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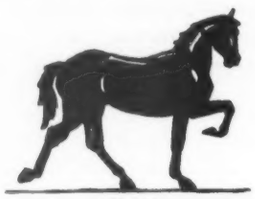
Why Any 10-Year Old Locomotive Is INADEQUATE

What Has Happened To HORSEPOWER!

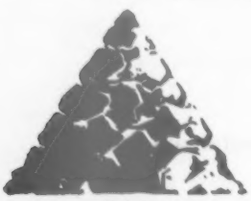
1912
475 H. P.
per driving axle

1922
575 H. P.
per driving axle

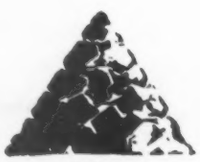


1932
OVER 1,000 H. P.
per driving axle

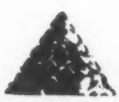
What Has Happened To FUEL CONSUMPTION!



1912
6½ LBS. COAL
per drawbar horsepower



1922
5 LBS. COAL
per drawbar horsepower



1932
3 LBS. OR LESS
per drawbar horsepower

SO rapid has been the advance of locomotive design that not a single locomotive in this country over ten years old can begin to hold its own with the really up-to-date power plant on wheels known as the Super-Power locomotive.

LIMA LOCOMOTIVE WORKS
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LIMA OHIO

Railway
Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

February - 1934

Annual Report of the Bureau of Locomotive Inspection

Twenty-second annual report shows that record of consistent progress in locomotive defects begun in 1923 was broken by rise in year ended June 30, 1933

THE twenty-second annual report of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission shows that the record of improvement in the condition of steam locomotives and the casualties and accidents resulting therefrom which was begun in 1923 has been broken. The report covers the activities of the Bureau for the fiscal year ended June 30, 1933, and in the case of locomotives inspected and found defective the percentage rose from 8 to 10 per cent in the past fiscal year. The number of locomotives inspected by the Bureau during the past fiscal year was 87,658. Of these 8,388 were found defective. The total number of defects found increased from 27,832 in 1932 to 32,733 in 1933, and the number of locomotives ordered out of service because of defects increased from 527 to 544. The increase in accidents and casualties brought about by the increase in defective locomotives and the converse are illustrated graphically in the chart accompanying this article.

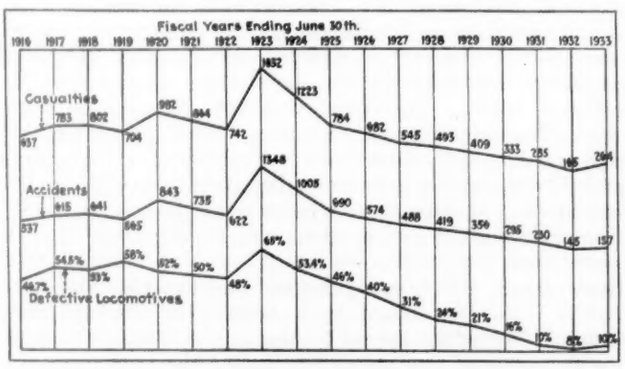
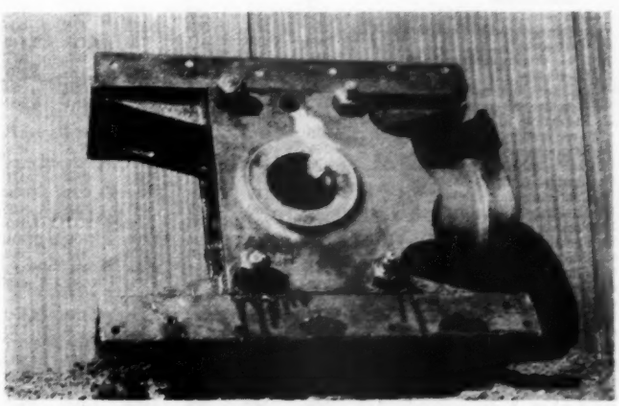


Chart showing the relation of defective steam locomotives to accidents and casualties resulting from locomotive defects



A crack in the pin boss of a crosshead caused by the application of fusion welding to reduce the diameter of the pin hole

Condition of Locomotives, Found by Inspection, in Relation to Accidents and Casualties

Fiscal year ended June 30	Per cent of locomotives inspected found defective	Number of locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1923	65	7,075	1,348	72	1,560
1924	53	5,764	1,005	66	1,157
1925	46	3,637	690	20	764
1926	40	3,281	574	22	660
1927	31	2,539	488	28	517
1928	24	1,725	419	30	463
1929	21	1,490	356	19	390
1930	16	1,200	295	13	320
1931	10	688	230	16	269
1932	8	527	145	9	156
1933	10	544	157	8	756

Boiler Explosions and Crown-Sheet Failures

There was a decrease of 16.6 per cent in the number of crown-sheet failures, a decrease of 71.4 per cent in the number of persons killed and a decrease of 33.3 per cent in the number of persons injured from this cause as compared with the previous year. Fatalities occurred

in two of the five crown-sheet failures caused by low water. Both of the locomotives involved were oil fired and in each instance the locomotive was in charge of an engine watchman who was killed. The assigned hours of each of these watchmen was such as to preclude the possibilities of obtaining sufficient rest without sleeping on duty. One of the watchmen was working on a tour of duty of 40 consecutive hours. The accident occurred at about the fourteenth hour of duty. The other watchman was assigned to shifts of 18 hours each, with six-hour rest periods intervening, and had been required to perform other service during his rest period. He had worked about 36 hours when the accident occurred.

Extension of Time for Removal of Flues

A total of 1,400 applications were filed for extensions of time for the removal of flues as provided in Rule 10. The investigation of the Bureau disclosed that in 78 of these cases the condition of the locomotive was such that extensions could not properly be granted. Sixty-seven were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Extensions were granted in 197 cases after the defects disclosed by the investigation had been repaired. Thirty-nine applications were canceled for various reasons. Applications were granted for the full period requested in 1,900 cases.

Under Rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives 151 specification cards and 3,601 alteration reports were filed, checked and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found. Under Rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives other than steam 98 specifications and 16 alteration reports were filed for locomotive units and 72 specifications and 71 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found. No formal appeal by any carrier was taken from the decisions of any inspection during the year.

Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts defective, inoperative or missing or in violation of rules	Year ended June 30—					
	1933	1932	1931	1930	1929	1928
1. Air Compressors	474	417	481	873	1,202	1,282
2. Arch tubes	51	54	60	87	104	103
3. Ash pans and mechanism	40	69	81	76	132	133
4. Axles	21	13	10	12	20	7
5. Blow-off cocks	210	144	191	325	442	469
6. Boiler checks	293	214	263	521	761	914
7. Boiler shell	296	220	430	579	841	954
8. Brake equipment	1,696	1,645	1,923	2,706	3,894	5,214
9. Cabs, cab windows, and curtains	1,183	851	1,484	3,066	2,140	1,670
10. Cab aprons and decks	309	262	415	710	1,005	852
11. Cab cards	121	162	211	226	305	378
12. Coupling and uncoupling devices	67	85	98	122	154	179
13. Crossheads, guides, pistons, and piston rods	773	763	856	1,421	1,887	2,088
14. Crown bolts	67	50	96	95	129	164
15. Cylinders, saddles, and steam chests	1,084	841	1,265	2,311	3,210	3,264
16. Cylinder cocks and rigging	374	376	411	848	967	1,007
17. Domes and dome caps	76	45	83	154	227	281
18. Draft gear	318	325	568	950	1,310	1,453
19. Draw gear	357	371	640	1,003	1,367	1,650
20. Driving boxes, shoes, wedges, pedestals, and braces	1,080	821	925	1,359	1,993	1,990
21. Firebox sheets	246	235	341	471	657	730
22. Flues	150	120	187	254	334	464
23. Frames, tailpieces, and braces, locomotive	669	611	740	1,271	1,377	1,354
24. Frames, tender	80	86	105	177	297	256
25. Gages and gage fittings, air	145	156	192	290	309	461
26. Gages and gage fittings, steam	258	214	324	553	678	969
27. Gage cocks	388	330	415	783	1,114	1,413
28. Grate shakers and fire doors	245	288	410	767	295	377
29. Handholds	363	392	562	865	1,125	1,373
30. Injectors, inoperative	20	31	55	103	86	93
31. Injectors and connections	1,357	1,168	1,815	3,275	4,484	5,563
32. Inspections and tests not made as required	6,358	3,801	4,863	7,456	9,246	6,623
33. Lateral motion	269	237	289	372	618	699
34. Lights, cab and classification	76	55	77	119	121	118
35. Lights, headlights	109	119	180	373	488	571
36. Lubricators and shields	157	119	176	312	423	500
37. Mud rings	232	166	318	445	636	822
38. Packing nuts	419	403	523	828	991	1,265
39. Packing, piston rod and valve stem	502	444	706	1,429	1,708	1,904
40. Pilots and pilot beams	123	145	160	272	371	386
41. Plugs and studs	151	176	182	348	482	619
42. Reversing gear	254	202	290	579	788	967
43. Rods, main and side, crank pins, and collars	1,327	1,256	1,520	2,488	3,465	4,152
44. Safety valves	53	63	61	116	170	172
45. Sanders	376	289	314	804	1,008	1,031
46. Springs and spring rigging	2,122	1,551	2,161	3,311	4,557	4,939
47. Squirt hose	93	96	184	313	387	478
48. Stay bolts	219	121	293	395	542	590
49. Stay bolts, broken	368	552	938	1,098	1,197	1,867
50. Steam pipes	338	285	512	730	925	1,020
51. Steam valves	193	143	226	399	471	708
52. Steps	498	622	676	1,021	1,394	1,817
53. Tanks and tank valves	600	587	732	1,426	1,717	1,941
54. Telltale holes	90	108	151	183	174	241
55. Throttles and throttle rigging	448	434	574	1,175	1,554	1,889
56. Trucks, engine and trailing	664	648	714	1,141	1,605	1,914
57. Trucks, tender	747	766	1,059	1,531	2,144	2,610
58. Valve motion	640	520	497	827	1,067	1,262
59. Washout plugs	623	599	815	1,283	1,871	2,211
60. Train-control equipment	4	13	9	48	60	112
61. Water glasses, fittings, and shields	716	676	955	1,501	1,816	2,115
62. Wheels	580	603	750	1,025	1,325	1,609
63. Miscellaneous—signal appliances, badge plates, brakes (hand)	423	325	418	601	1,101	1,273
Total number of defects	32,733	27,832	36,968	60,292	77,268	85,530
Locomotives reported	56,971	59,110	60,841	61,947	63,562	65,940
Locomotives inspected	87,656	96,924	101,224	100,794	96,465	100,415
Locomotives defective	8,388	7,724	10,277	16,300	20,185	24,051
Percentage of inspected found defective	10	8	10	16	21	24
Locomotives ordered out of service	544	527	688	1,200	1,490	1,725

A driving-wheel tire that broke while an attempt was being made to build up the flange by fusion welding

A broken tender-truck axle caused by the application of fusion welding to attach brackets to the axle to prevent the retaining collar of train-control transmission from shifting on the axle

The Locomotive Smoke Nuisance*

Its elimination reduces fuel costs by increasing efficiency of combustion, and also removes prolific source of irritation

RAILROADS have been serious offenders because of smoke from the locomotives and at engine terminals. There was a time when general standards of cleanliness and neatness were such that nuisances of this sort were tolerated more or less as a necessary evil. Today, however, in most parts of the country such smoke is a constant source of irritation and does much to alienate the goodwill of that part of the public which is subjected to it. A number of cities, particularly the larger ones, have attempted to control the smoke nuisance, and in general with good results.

The railroads have the reputation for making much of the smoke in some communities, although, as a matter of fact, in many instances they are among the least important of the offenders from the standpoint of air pollution as a whole. Nevertheless, the dirt and the untidy appearance of many localities adjacent to engine terminals and yards, and along the right-of-way, cannot help but lower the morale of people living in such districts. Surely, also, it does not help the railroads in their fight to rebuild traffic and secure the goodwill of the public.

Meet the Smoke Expert!

I wondered what a typical Smoke Commissioner of a community which has achieved some considerable success in reducing the amount of smoke, might have to say as to how railway mechanical department officers and employees could co-operate to secure better results in the elimination of smoke, which because it is an indication of more efficient combustion, will reduce fuel expenses and at the same time eliminate criticism and condemnation on the part of the traveling public and the communities through which the railroad operates. I put this question squarely up to the Smoke Commissioner.

"In general," he replied, "we have received excellent co-operation from the railroads. One or two roads have practically eliminated smoke from locomotives. At the other extreme, however, are some which have evinced little interest and apparently we shall not get results unless we put on the spurs."

"Can you cite a specific instance of such lack of interest?" I asked.

Poor Judgment

"Surely," he replied. "Here, for instance, is a road that has a splendid reputation because of its excellent passenger service. Travelers on its trains are enthusiastic about the comfort of the equipment, the courtesy of the employees and the high standards and low cost of the dining car service. It has well designed locomotives, with large fireboxes, so that there should be excellent combustion with a minimum of smoke. For some reason, however, the officers and employees seem to be indifferent about the amount of smoke made by the locomotives; and, as you can see from the monthly statement, the road is well down the list on the basis of smoke elimination performance. Apparently the assumption is that if the travelers inside the cars can be protected, nothing else matters.

"As a matter of fact, however," he continued, "it must not be forgotten that there are many potential customers alongside the railroad that suffer from the needless smoke and dirt and therefore can hardly be expected to patronize or boost the railroad or be very much interested in seeing that it gets a square deal, either from the municipalities through which it operates or on the part of the state or federal authorities. It does seem to me that by co-operating with us in preventing smoke, the mechanical departments of the railroads can make friends for their roads and help to build up the traffic."

Induction Tubes and Ring Blowers

"Are there any mechanical contrivances which will automatically assist in reducing the amount of smoke?" I asked.

"Quite decidedly so," replied the Smoke Commissioner. "Interestingly enough, some of these devices are standard on some of the roads and are taken as a matter of course, while others lean back in a critical way, claiming that the devices are no good, and more or less of a nuisance. Take the matter of air induction tubes in fireboxes, for instance. It is not a very expensive job to install them and yet these tubes are a large factor in increasing the efficiency of combustion. Undoubtedly they will pay for themselves on this basis in a reasonably short time, and at the same time will go a long way toward eliminating smoke.

"Then there are the ring blowers, in place of the ordinary blower pipes in the front end. These make it possible to distribute the draft through the stack to better advantage, this in turn causing a better distribution of the air in the firebox, again improving the efficiency of combustion. The ring blower has another decided advantage. We have had many complaints because of the noise where ordinary draft pipes are used. This is greatly reduced and dampened by using ring blowers. Here, again, the blowers are not very expensive, should appeal to the managements from an engineering point of view, and undoubtedly, in addition to doing away with sources of irritation to the public, will pay for themselves in a reasonable time because of improved combustion."

Firing Up Locomotives

"How about smoke from the enginehouses?" I asked.

"The worst part of this smoke," replied the Smoke Commissioner, "is, of course, caused by the firing up processes. You must expect smoke—and plenty of black smoke—if you use oil saturated waste or oil in any form to start the fires. Many roads have greatly reduced the amount of smoke in the enginehouses by using dry wood for firing up purposes; mind you, I do not say *wood*, but *dry wood*. Sufficient coal is first placed

* Seventh of a series of interviews with men outside the mechanical department, commenting in a constructive way upon the possibilities of that department.

in the firebox to insure a good fire until the engine gets well out of the house. A shallow depression, deepening toward the middle, is formed in this coal bed and this is filled with dry wood. It does take a little more time to build the fire in this way, but it is time well spent because of the greater cleanliness in and about the enginehouse. Incidentally, little difficulty is found on most roads in gathering up a sufficient amount of wood for this purpose at low cost."

Stimulating Interest

"What other things would you suggest to help secure an improvement?"

"Obviously," replied the Smoke Commissioner, "we cannot expect to make any real and substantial improvement without first getting the men in the enginehouses and on the locomotives interested in the problem and thoroughly informed as to how to do their work in such a way as to reduce and eliminate the smoke. One road in our district, for instance, has a minimum of the mechanical contrivances I have mentioned, but the engine crews are intensely interested in the records that they are making, with the result that excellent performance is secured. Informal smoke meetings are held monthly at the terminal.

"It is, of course, our practice," he continued, "when we make a smoke reading and find a bad condition, to report immediately to the railroad concerned the number of the engine and the time that the reading was taken. If it is at all possible, our representative, when he takes the reading and sees that conditions are bad, will board the engine and try to explain to the crew how better results may be secured. At any rate, when a poor smoke reading is reported, it is the practice on some of the more interested roads to call the crew in and ask for an explanation. In some instances the brotherhoods, in order to protect their members, have been quite helpful in stimulating interest and encouraging the men to improve their practices."

"Can you induce a competitive spirit?" I asked.

"Yes," replied the Smoke Commissioner. "Because of a certain amount of friendly rivalry among some of the roads in our district, we are never quite sure as to exactly what the order of performance of the better roads will be on the monthly report. The only difficulty is that thus far we have been unable to stimulate all of the roads to this spirit of competition, and the tail-enders on the list have more or less consistently held that position for quite some time.

"On the other hand," continued the Commissioner, "it is significant that the combined record of all of the roads for the month of December last is by far the best that has ever been reported. For this reason I hope you will not think I have been too critical in my suggestions. It does indicate that all of the roads have co-operated to a greater or less extent and we are proud of the record that they have made. This, in turn, helps us to secure a greater amount of co-operation from the industrial plants in our district."

Locomotive Counterbalancing*

By Lawford H. Fry

A systematic method of analyzing the dynamic effects of rotating weights and of cross-balancing—The author points out the need for complete and accurate analysis, particularly where dynamic augment must be kept within rigid limits

IN modern locomotive designing the proper counterbalancing of the rotating and reciprocating parts deserves close attention. Methods used up to a few years ago are inexact and allow high unbalanced inertia forces with destructive effect on the track. In Europe the civil engineers of the railroads require all possible protection for the permanent way and as a result correct balancing of locomotives has been common practice. In recent years some locomotive engineers in this country have adopted methods of cross-balancing which have reduced the unbalanced inertia forces and have thus cut down the dynamic augment of wheel loads produced by these forces. However, the great majority of locomotives designed ten years or more ago are balanced for static conditions only. In these locomotives the main axle load on the track may be increased and decreased by 20,000 pounds or more during each revolution. Little argument should be needed to show the desirability of avoiding the large and unnecessary stresses thus imposed on the track.

Acceptance of this unnecessary dynamic augment in the axle load cannot be excused on the grounds of simplification of design. The great reduction in track stresses secured by elimination of unnecessary dynamic augment requires only that the counterbalance be set a few degrees off the center line of the crank. The necessary increase in weight of the counterbalance is small. Some refinements are necessary in weighing the wheels to see that they are correctly balanced. These, however, should present no real difficulty with adequate mechanical engineering talent and proper shop management.

It is occasionally argued that it is unnecessary to consider cross-balancing for certain types of locomotives because the wheel centers are too small to take all of the balance desired. This excuse is not valid. It is shown later that even with less than complete balance a shift of the center of gravity of the balance by about seven degrees may reduce the dynamic augment on the main axle by over 10,000 lb. The possibility of this reduction should not be neglected.

It is not easy to see why American civil and mechanical railway engineers have neglected for so long the

*A paper presented before the annual meeting of the American Society of Mechanical Engineers, December 5, 1933. Contributed by the Railroad Division.

proper balancing of locomotives. Probably one reason for this neglect has been the lack of a simple method for analyzing the inertia forces and presenting the facts. The present paper attempts to fill this gap. It offers a complete and accurate method for analyzing the inertia effects of the rotating parts of a locomotive engine. The method serves a double purpose. In the first place, it shows exactly what unbalanced inertia forces are developed by a given locomotive. In the second place, it enables a designer to arrange the counterbalance of a locomotive so as to secure the best possible results for any given conditions.

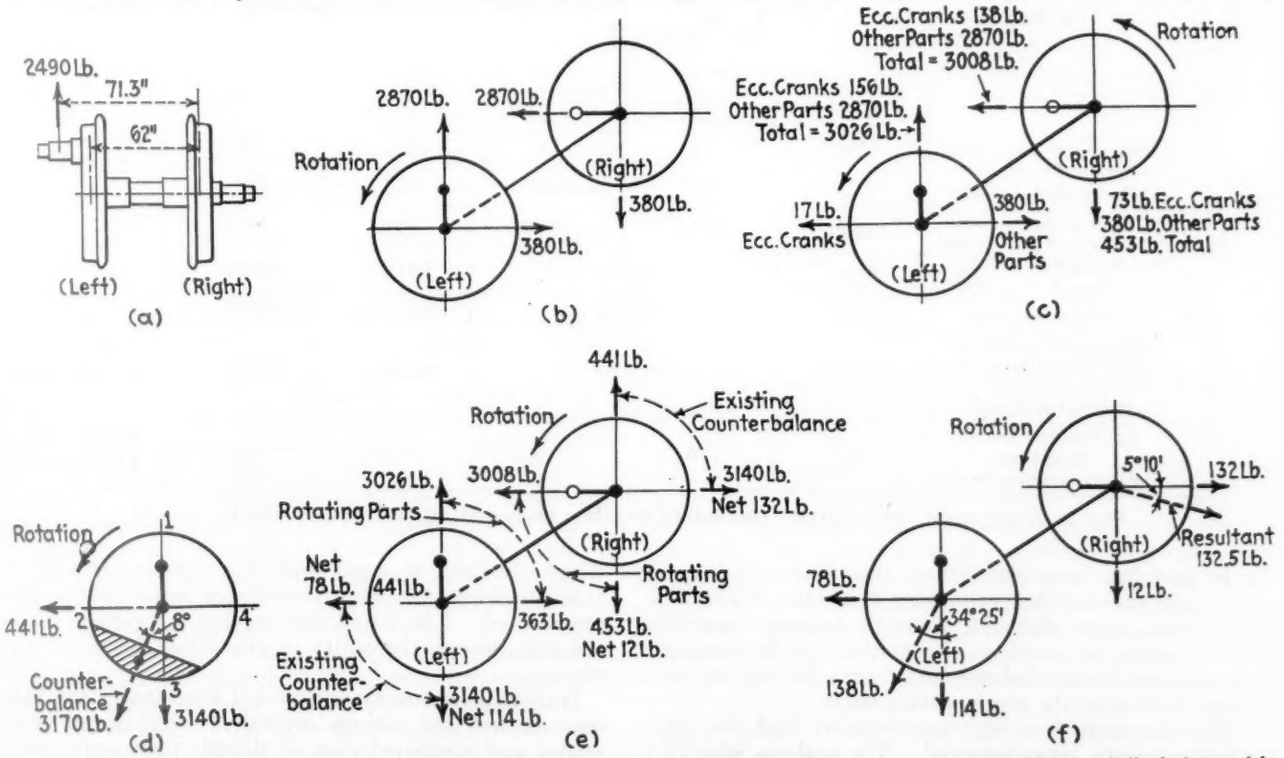
The paper describes in detail all of the computations to be carried out and keeps the mathematics down to the inescapable minimum. The final results are presented in simple form so that they may be readily understood by executives too busy to unravel the usual intricacies of cross-balancing.

It is believed that general use of this method will accelerate the progress in improved balancing that has begun in the last few years. The present interest in the reduction of track stresses by proper balancing is directly traceable to the track stress measurements begun in 1913 by Prof. A. N. Talbot for the American Railway Engineering Association. C. T. Ripley of the Atchison, Topeka and Santa Fe co-operated with Prof. Talbot in this work and was much impressed by advantages to be gained by designing locomotives to reduce track stresses. Improved distribution of weight and elimination of flangeless tires were tried and found to be efficacious. Prof. Talbot's tests also showed the large unnecessary stresses were due to imperfect balancing of locomotives. In 1924 Mr. Ripley arranged for the cross-balancing of a large Santa Fe type locomotive and the writer worked with Mr. Ripley on the preliminary computations of the balance for this engine. In 1926 Mr. Ripley reported to the American Railway Association, Mechanical Division, that the experimental locomotive gave a satisfactory reduction in track stresses. On this foundation a considerable amount of improvement in locomotive balancing has been built. In 1930 the Committee on Locomotive Construction reported to the American Railway Association, Mechanical Division, a proposed method for dynamic or cross-balancing and in 1932 the Committee's method was adopted by the Association as Recommended Practice.

The present paper starts with the American Railway Association method of computation and modifies and extends this. In addition a method is provided for a complete analysis of the inertia forces of an existing locomotive. Special attention is called to the method of presenting the results of this analysis. Although entirely accurate, the results are presented in very simple form.

Systematic Method of Counterbalance Analysis

In each pair of wheels all of the inertia forces of the rotating parts and of the counterbalances are combined so that they are completely represented by two equivalent weights in each wheel. These weights act in the plane of rotation of the center of gravity of the counterbalance. In this plane one equivalent weight acts along the wheel diameter through the crank pin and the other perpendicular to this diameter. When this pair of representative equivalent weights is set down for each wheel, as shown in Fig. 2, the exact conditions of balance of the locomotive can be seen very readily. The equivalent weight acting along the crank diameter represents, in each wheel, the over-balance or under-balance acting to balance or to reinforce the inertia forces of the reciprocating parts. The equivalent weight acting at right angles to the crank is a parasitic effect due to incomplete cross-balancing. The resultant of the two equivalent weights at right angles to each other, shown by broken lines in Fig. 2, determines the maximum value of the dynamic augment. If the parasitic



(a) Equivalent weight representing all rotating parts in left main wheel, except eccentric cranks and counterbalance. (b) Equivalent weight in counterbalance planes representing all rotating parts, except eccentric cranks and counterbalances. (c) Equivalent weight representing eccentric cranks and all other rotating parts, except counterbalances. (d) Equivalent weight and position of existing counterbalance and component equivalent weight representing counterbalance. (e) Component equivalent weights representing all rotating parts, including counterbalances. (f) Component and resultant equivalent weights in counterbalance planes of main wheels representing combined effect of all rotating parts, including counterbalances.

Fig. 1—Analysis of inertia effects in main wheels

effect is large enough to produce an undesirably large increase in the dynamic augment, it can be reduced by cross-balancing.

With this as introduction, the method proposed by the author will be considered in more detail. The method is described by using it to analyze the inertia forces set up by the rotating parts of an existing 4-8-2 type of locomotive. This engine which has been in satisfactory service for about six years has the main pair of driving wheels partially cross-balanced. The locomotive is of the 4-8-4 type with dimensions as follows:

Cylinders:	
Diameter	30 in.
Stroke	30 in.
Driving-wheel diameter	73 in.
Weight:	
First pair of drivers	66,500 lb.
Second pair of drivers (main axle)	70,500 lb.
Third pair of drivers	66,500 lb.
Fourth pair of drivers	66,500 lb.
Total on drivers	270,000 lb.
Total locomotive	420,000 lb.

When the original design of the locomotive was under consideration it was stipulated that at diameter speed, that is at 73 miles per hour, the combined static and dynamic rail load of any axle should not exceed 75,000 lb.

This is a highly intelligent method of setting the limits to be worked to in counterbalancing. After each static axle load has been established, the difference between this static load and the permissible maximum of 75,000 lb. is the maximum allowable dynamic augment permitted for the axle in question. From this can be computed the amount of over-balance which may be put into each wheel to balance the reciprocating parts.

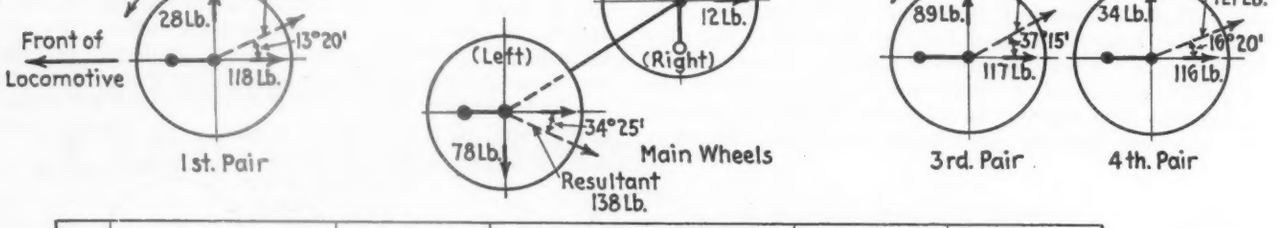
The locomotive under consideration had the main wheels partially cross-balanced. The analysis which follows shows that the final results in this pair of wheels differed somewhat from that aimed at. The deviation is due to two causes. In the first place, the eccentric cranks were assumed to be concentrated at the crank pin, while the present more accurate analysis takes into account the fact that the center of gravity of the eccentric cranks does not fall on the main crank radius. In the second place, the position of the counterbalance to give correct cross-balance for the rotating parts was determined and the over-balance for the reciprocating parts was then added without changing the position of the counterbalance.

The difference between the result aimed at and that obtained is not large, but is sufficient to show that any counterbalance scheme should be accurately analyzed before the locomotive design is accepted as satisfactory.

All computations necessary for an accurate analysis of the system of rotating parts are described in detail in the Appendix.* A step by step method is used so that those who carry out such computations infrequently may be able to follow the reasoning involved.

Before considering the application of the method to the example, a word of explanation of the term "equivalent weight" is in order. This term has been introduced to simplify the mathematics and to avoid the necessity for introducing the speed of the locomotive. Instead of calculating with "masses" or with "centrifugal forces", the "equivalent weights" are used. The inertia effect of each rotating mass is represented by its equivalent weight. Equivalent weight is defined as the weight of that mass which, rotating at crank radius about the axis of the axle, produces the same centrifugal force as the mass represented. The equivalent weight is assumed to act radially through the center of gravity of the mass it replaces.

If their positions, directions and magnitudes are taken into account, the various equivalent weights can be resolved and combined just as though they were forces. They, of course, represent forces which are proportional to their magnitudes and to the square of the speed of



Line		1st. Pair	Main Wheels		3rd. Pair	4th. Pair	
			Left	Right			
1	Resultant Equivalent Weight Producing Dynamic Augment	Lb.	Lb.	Lb.	Lb.	Lb.	
		121	138	132.5	147	116	
2	Dynamic Augment at Diameter Speed — Per Wheel	5800	6630	6360	7050	5800	
3	Dynamic Augment at Diameter Speed — Per Axle	8200	6570		9950	8200	
4	Static Axle Load	66500	70500		66500	66500	
5	Maximum Combined Static and Dynamic Axle Load at Diameter Speed	74700	77070		76450	74700	Total Overbalance
6	Equivalent Weight Opposing Reciprocating Parts	118	114	132	117	116	465 Lb. Left 483 Lb. Right

Fig. 2—Component and resultant equivalent weights representing unbalanced inertia forces

* The Appendix will be printed in the next issue.—Editor.

rotation of the wheel. To speak mathematically, they are vector quantities.

We now consider the processes by which, in each pair of wheels, the inertia effects of all rotating parts, including the counterbalances, are resolved into and represented by two pairs of equivalent weights. One pair acts in each wheel in the plane of rotation of the center of gravity of the counterbalance. In each of the counterbalance planes, one equivalent weight of the pair acts along the diameter through the crank pin with the other weight of the pair acting at right angles to this diameter.

Unsymmetrical Effect of the Eccentric Crank

The main pair of wheels is taken as an example. Weights and positions of the rotating masses are assumed to be as given in the Appendix. Steps in the analysis are illustrated in Fig. 1. First, by the method of Section I of the Appendix, all rotating parts in one wheel, except eccentric cranks and counterbalance are replaced by a single equivalent weight of 2,490 lb. acting in a plane 71.3 in. from the central plane of the counterbalance in the opposite wheel. See Fig. 1(a). The distance between the central counterbalance planes is 62 in. This resultant equivalent weight of 2,490 lb. must be resolved into two components, one in each counterbalance plane, as described in Section II of the Appendix. When this is done for both wheels of the pair, each wheel has an equivalent weight of 2,870 lb. acting along the crank radius, and an equivalent weight of 380 lb. at right angles to the crank, as shown in Fig. 1(b). The inertia effect of the eccentric cranks must now be similarly resolved into two equivalent weights in each counterbalance plane. The method of computation is described in Section III of the Appendix. The results are shown in Fig. 1(c), together with the component equivalent weights already found for the other rotating parts. In the left main wheel the inertia effect of the eccentric cranks is represented by two equivalent weights. One weight of 156 lb. acts along the crank radius. The other of 17 lb. acts along the radius 90 deg. ahead of the crank. In the right wheel, the components for the eccentric cranks are 138 lb. along the crank radius and 73 lb. at 90 deg. ahead of the crank. Owing to the position of the eccentric cranks, their effect is not symmetrical in the two wheels of the pair.†

Combining the components of eccentric cranks and other rotating parts, the result is set down as in Fig. 1(c) and to this, the inertia effect of the counterbalance as determined below is added. The locomotive under analysis had in each main wheel a counterbalance with an equivalent weight of 3,170 lb. with its center of gravity set in each wheel 8 deg. behind the crank diameter. See Fig. 1(d). This can be resolved into two components at right angles to each other, as shown in Fig. 1(e). The detailed method for this resolution of the counterbalance effect into two component equivalent weights is given in Section VII of the Appendix. These components are an equivalent weight of 3,140 lb. along the crank diameter opposite the main pin and another equivalent weight of 441 lb. 90 deg. behind the first.

It is now only a matter of simple subtraction to arrive at the final result of Fig. 1(f). The unbalanced inertia effect of all rotating parts including eccentric cranks and counterbalance in the left counterbalance plane is represented by an equivalent weight of 114 lb. along the crank diameter opposite the main pin and 78 lb. at 90 deg. back of this. In the right hand counterbalance plane the unbalanced inertia effects are represented by an equivalent weight of 132 lb. opposite the right-hand crank pin and an equivalent weight of 12 lb. acting 90 deg. back of this.

Fig. 1(f) gives a complete representation of the unbalanced inertia forces in the main wheels. All rotating parts including eccentric cranks and counterbalances are covered. In each counterbalance plane there are two component equivalent weights at right angles to each other. These can be combined into a single resultant as shown.

The main pair of wheels being disposed of, the other coupled wheels must be dealt with in the same way. It is convenient to use a blank form similar to Fig. 1 for setting down the various steps in the calculation, omitting details which pertain only to the main wheels. Details of the computations are not given here, but the final results for the four pairs of main and coupled wheels are shown in Fig. 2. Except in the case of the main pair of wheels, the right and left hand wheels on each axle have the same equivalent weights and therefore only one wheel of each pair is shown. The lack of symmetry in the main wheels is due, as explained above, to the position of the eccentric cranks.

It is important to use a form similar to that of Fig. 2 for showing the results obtained, as this gives complete information regarding the unbalanced inertia forces in the simplest possible form. The information thus given puts the locomotive designer in a position to give critical consideration to the balance system which has been applied or which is proposed for application.

The balancing of the locomotive under consideration will now be reviewed. Two points are of major importance, the dynamic augment and the amount of balance provided for the reciprocating parts.

Dynamic Augment

The force producing dynamic augment in each wheel is proportional to the resultant equivalent weight shown for that wheel in Fig. 2. This force is computed from the resultant equivalent weight by the usual formula for centrifugal force:

$$F = 0.0000284\ W\ R\ n^2$$

where F = force in pounds
W = equivalent weight in pounds
R = crank radius in inches
n = revolutions per minute

At diameter speed the wheels make 336 r.p.m. At this speed the centrifugal force is:

$$F = 3.2\ R\ W$$

For the locomotive under consideration, which has a crank radius of 15 in., this equation takes the form

$$F = 48\ W$$

That is, the maximum dynamic augment in each wheel is 48 times the resultant equivalent weight in that wheel. Values corresponding to this are shown in line 2 of the tabulation in Fig. 2 for all of the wheels. The values here are the maximum values of the force which alternately increases and decreases the wheel load on the rail during each revolution. The maximum increase, or maximum dynamic augment, occurs in that position of the wheel in which the resultant equivalent weight is directed vertically downward. It is evident that the maximum values for right and left hand wheels on one axle do not occur at the same time. Consequently, the maximum increase in axle load is not the sum of the maximum increases in the two wheels. Section V of the Appendix gives a method for determining the maximum axle load and the corresponding position of the wheels when the resultant equivalent weights in the two

† The author is indebted to C. H. Bilty, mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific, for calling attention to the desirability of considering the eccentric cranks separately from the other revolving parts on the crank pin.

wheels are different and are set at any angle. If the resultant equivalent weights are the same in both wheels of a pair and act at 90 deg. apart, the maximum axle load occurs when the resultants in both wheels are directed downwards at an angle of 45 deg. from the vertical. The maximum dynamic augment for the axle is then 1.414 times the maximum for each wheel. In the locomotive under consideration this is the case for all of the coupled wheels except the main pair.

In the main pair of wheels, the planes through the resultant weights and the axis of the axle stand at an angle of 119 deg. 15 min. and the resultants have the values of 138 lb. in the left and 132.5 lb. in the right wheel. By applying the method of Section V of the Appendix, it is found that the equivalent weight producing the maximum axle load is 137 lb. This does not differ greatly from the individual resultants in the wheels.

It should be noted that the relation between maximum axle load and maximum wheel load depends on the angle between the wheel resultants. The extreme cases are (1) with zero angle betwen the resultants the increase in axle load is twice the wheel load, and (2) with 180 deg. between the resultants the increase in axle load is zero.

If the angle between the resultants is large, so that the increase in axle load is small, it will probably be desirable to consider the increase in wheel load as the limiting factor rather than the increase in axle load. The axle load measures the influence of the locomotive on a track unit such as a bridge, while the wheel load determines the influence on an individual rail.

Overbalance for Reciprocation Parts

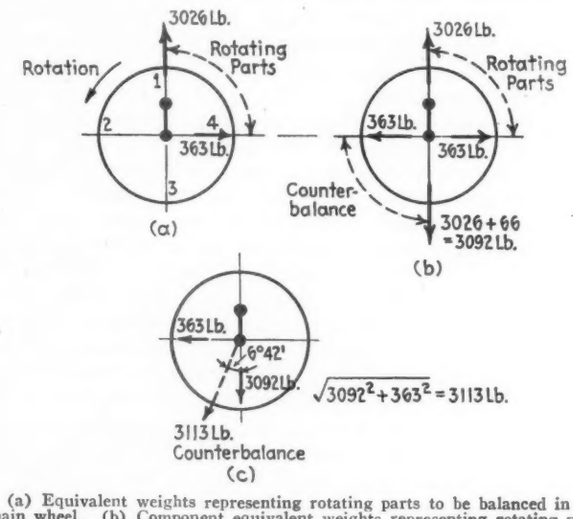
Returning to a consideration of Fig. 2: Line 3 shows the maximum dynamic augment per axle at diameter speed and line 4 shows the static axle load. Line 5, the sum of the two preceding lines, gives the maximum combined static and dynamic axle load at diameter speed. It was intended when designing the locomotive that this combined axle load should not exceed 75,000 lb. This limit is observed in the front and back wheel pairs, but is slightly exceeded in the main and third pairs of wheels. If an analysis had been made in this form before the locomotive had been built, it would have been a simple matter to determine the weight and position of counterbalances which would keep to the desired axle load.

The general method is described in Section VI of the Appendix. In the main axle, the maximum dynamic augment permissible is 75,000—70,500 = 4,500 lb. This corresponds to an equivalent weight of 94 lb. on the axle. If the resultants in the wheels are equal and act at 90 deg. apart, the value of each will be 66.3 lb.* Assume then that each of the main wheels is to be balanced so that the resultant producing dynamic augment in the wheel is 66 lb. It is desirable to eliminate any parasitic effect and to have the full weight of this resultant acting opposite the crank pin so as to be available for balance of the reciprocating parts.

In the left main wheel, the rotating parts are represented as shown in Fig. 3(a) by equivalent weights of 3,026 lb. along the crank diameter and 363 lb. acting 90 deg. back of this. To produce the desired balance, the components of the counterbalance must be 363 lb. opposing the same weight at right angles to the crank, and 3,026 + 66 = 3,092 lb. opposite the pin as shown in Fig. 3(b). These components when combined as in Fig. 3(c) show that the counterbalance itself must have an equivalent weight of 3,113 lb. with its center of gravity set 6 deg. 42 min. back of the crank diameter. Comparing this with the counterbalance as applied, it is seen that by reducing the equivalent weight from 3,140 lb. to 3,113 lb. and changing the angle from 8 deg. to 6 deg. 42 min., the unbalanced resultant equivalent weight is reduced from 138 to 66 lb. with a reduction of 3,350 lb. in the dynamic augment of the wheel at diameter speed.

This illustration shows that when the present method is used to resolve the inertia effects into two equivalent weights in each wheel, it is a very simple matter to determine the balance required to meet any desired conditions.

By applying the same method to the right hand main wheel, it is found that for complete balance except for an over-balance of 66 lb. opposite the pin, the counterbalance must have an equivalent weight of 3,107 lb. set 8 deg. 23 min. off the diameter. The difference between the counterbalance found for the right and left hand main wheels is not large. It is desirable for practical



(a) Equivalent weights representing rotating parts to be balanced in left main wheel. (b) Component equivalent weights representing rotating parts and desired counterbalance. (c) Components and resultant equivalent weight giving counterbalance desired.

Fig. 3—Determination of counterbalance to give complete cross-balance and desired over-balance of 66 lb.

reasons of manufacture to make both wheels the same. A satisfactory balance can be obtained by giving the actual counterbalance in both wheels an equivalent weight of 3,110 lb. set at an angle of 7 deg. 30 min. off the diameter. This weight and angle are obtained by averaging the values found as above for the right and left hand wheels. With this counterbalance the left wheel will have an over-balance of 56 lb. and a resultant of 71 lb., while the right wheel will have an over-balance of 74 lb. and a resultant of 87 lb. The left wheel is slightly under and the right wheel slightly over-balanced, but the difference is not serious.

In addition to the main pair of wheels, it will be seen from Fig. 2 that the third pair also exceeds the proposed limit of 75,000 lb. for combined static and dynamic load. The dynamic augment exceeds the estimated figure by 1,450 lb. because the wheels were not cross-balanced. Cross-balancing would have involved changing the equivalent weight of the counterbalance from 1,130 to 1,133 and moving its center of gravity 4 deg. 30 min. away from the crank diameter. This would eliminate the parasitic effect of 89 lb., leaving the over-balance the same, 117 lb., and reducing the resultant producing dynamic augment from 147 to 117 lb. This reduction of 20 per cent in the dynamic augment is well worth considering if the locomotive is being built to a closely restricted weight.

In the fourth pair of wheels, the desired over-balance

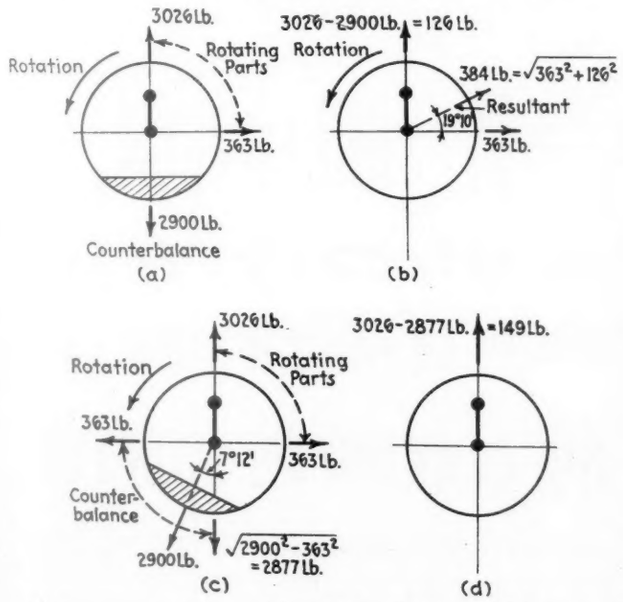
* 94 ÷ 1.414 = 66.3.

opposite the crank pin is 116 lb. The parasitic effect which could be eliminated by cross-balancing, is 34 lb. These produce a resultant of 121 lb. Cross-balancing by eliminating the parasitic 34 lb. would reduce the equivalent weight producing dynamic augment from 121 to 116 lb., that is by only 4.1 per cent. The reduction is hardly enough to be worth while.

As a general rule, it may be noted that unless the parasitic effect to be eliminated by cross-balancing amounts to more than 30 per cent of the over-balance the reduction in the resultant produced by cross-balancing will not be more than 4.5 per cent, and therefore hardly justifies the additional complication.

Cross-Balancing with Small Wheels

Before leaving the balance of rotating parts, consideration must be given to the desirability of cross-balancing when the wheel centers are too small to allow the full amount of balance to be applied. Assume that in a main wheel the component equivalent weights representing the rotating parts are as found for the left main wheel of the locomotive already examined, that is 3,026 lb. along the crank radius and 363 lb. at right angles to this. Assume also that the wheel design limits the equivalent weight of the counterbalance to 2,900 lb. If this is put exactly opposite the pin as in Fig. 4(a), it is obvious that the unbalanced components will be as in Fig. 4(b), 126 lb. along the crank and 363 lb. at 90 deg., giving an unbalanced component of 384 lb. producing dynamic augment. This can be reduced materially by shifting the equivalent weight of 2,900 lb. 7 deg. 12 min. off the crank diameter. As shown in Fig. 4(c) this gives components of 2,877 pounds opposite the pin and 363 lb. at right angles to this. The position is chosen so the component at right angles to the crank diameter is just equal and opposite to the component of the rotating parts acting at right angles to the crank. The simple calculation required to determine the other component is obvious from Fig. 4(c). The components being 363 and 2,877 lb., the tangent of the angle at which the counterbalance must be set at $363 \div 2{,}877 = 0.1265$, which is the tangent of 7 deg. 12 min. Combination of the four components in Fig. 4(c) shows that the net unbalanced equivalent weight is 149 lb., as in Fig. 4(d), instead of 384 lb. when the counterbalance was directly opposite the pin as in Fig. 4(a). This large reduction in the unbalanced force producing dynamic augment makes cross-balancing well worth while even though full balancing is not possible.



(a) Component equivalent weights with insufficient counterbalance placed opposite crank pin. (b) Component and resultant equivalent weights representing unbalanced inertia forces of arrangement (a). (c) Position of insufficient counterbalance to give least possible unbalanced inertia forces. (d) Net equivalent weight representing unbalanced inertia force resulting from arrangment (c).

Fig. 4—Incorrect and correct positions for insufficient counterbalance

Consideration must now be given to the over-balance provided for the reciprocating parts. Fig. 2 shows that the over-balance amounts to 465 lb. on the left and 483 lb. on the right hand side. The locomotive under consideration had reciprocating parts weighing 2,241 lb. on each side of the engine. Approximately 80 per cent of the weight of the reciprocating parts is unbalanced. This is very much more than the 50 per cent set up by the American Railway Association as recommended practice. In spite of this, the locomotive rides satisfactorily.

The fact is that the A. R. A. practice needs further consideration. In the first place, there is no logical reason for specifying the over-balance as a percentage of the weight of the reciprocating parts. The proper course is to consider the unbalanced weight in comparison with the total weight of the locomotive. The unbalanced portion of the reciprocating parts tends to shake the locomotive. This shaking is resisted by the inertia of the locomotive as a whole. Consequently the stability of the locomotive is determined by the relation of the mass of the whole locomotive to the mass of the unbalanced parts. This principle was stated by George R. Henderson over twenty-five years ago, but has not received the recognition it deserved.

Henderson suggested that one four-hundredth of the weight of the locomotive might remain unbalanced on each side. That would be 2.50 lb. unbalanced per 1,000 lb. of locomotive weight. The 4-8-4 type locomotive analyzed has 4.2 lb. unbalanced per 1,000 lb. Other locomotives analyzed in the same way show unbalanced weights of 5.4 lb. per 1,000 for a 2-8-4 type and 3.8 lb. per 1,000 for a 4-6-4 type. All are reported to ride satisfactorily.

The conclusion to be drawn is that if the rotating parts are properly balanced, it is only necessary to balance a comparatively small portion of the reciprocating parts.

Further study of results obtained in practice is desirable, but if the reports of such results are to have any value they must be based on an accurate analysis of the balance similar to that which has been described.

To complete this examination of the inertia forces it is necessary to take into account the fact that the inertia forces of the reciprocating parts act in the vertical plane through the center of the main rod while the inertia force of the over-balance acts in the central plane of the counterbalance. This difference in plane can usually be neglected. Its effect is to tend to turn the locomotive about a vertical axis. This tendency will have no perceptible effect on a long modern locomotive. In adjusting the over-balance to offset the inertia forces of the reciprocating parts, it is only necessary to consider the longitudinal forces. The couple about the vertical axis due to the difference between the planes of action can be neglected. Cross-balance is therefore not necessary for the over-balance for the reciprocating parts.

In conclusion, the author repeats what he has said before in addressing the society. It is important for railroad engineers to adopt an accurate method for analyzing the balance of a locomotive. It is also highly important that the results obtained by the analysis be stated in a simple manner free from involved mathematics. If this is done, the advantages of proper balancing methods will be self-evident and improvements will follow.

Air-Conditioned Passenger Cars in Service in the United States, December 31, 1933

Railroad	No. of cars	Type of cars	Date equipped	Type of system	Manufacturer of system	Compressor drive	Generators: No.	Generators: Capacity, kw.	Generators: Type of drive	Generators: Type of mounting	Refrigerant	Storage batteries: Make	Storage batteries: Amp.-hr. capacity	Outside power supply: Current Characteristics: a. c. or d. c.	Outside power supply: Current Characteristics: Phase	Outside power supply: Current Characteristics: Cycles	Outside power supply: Current Characteristics: Volts	
Alton	4	Diners	7-1932	Mech.	B. & O.—York	5-hp. motor	2	1—4 1—7½	Flat belt Belt and gear	Body	Freon	Exide	1,000	d. c.	....	....	32	B. c. r.*
	4	Coaches	7-1932	Mech.	B. & O.—York	5-hp. motor	2	1—4 1—7½	Flat belt Belt and gear	Body	Freon	Exide	1,000	d. c.	....	....	32	B. c. r.
	6	Parlor	7-1932	Mech.	B. & O.—York	5-hp. motor	2	1—4 1—7½	Flat belt Belt and gear	Body	Freon	Exide	1,000	d. c.	....	....	32	B. c. r.
	2	Obs.-Lounge	7-1932	Mech.	B. & O.—York	5-hp. motor	2	1—4 1—7½	Flat belt Belt and gear	Body	Freon	Exide	1,000	d. c.	....	....	32	B. c. r.
A. T. & S. F.	1	Diner	7-1930	Mech.	Carrier	Motor	2	7½	Gear	Truck	Ammonia	Exide	2,250	d. c.	....	....	32	B. c. r.
	22	Diners	1932	St. eject.	Safety C. H. & L.	.....	1 1	2 4	Flat belt Flat belt	Truck	Water	Exide	900	d. c.	....	....	32	B. c. r.
B. & O.	32	Diners	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
	13	Coaches	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
	8	Reclin. chair	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
	5	Lounge	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
	3	Comb.	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
	1	Official	1931-1933	Mech.	B. & O.—York	5-hp. motor	1 1	4 7½	Flat belt Belt and gear	Body	Freon	Exide—USL and K. W.	576—864 and 1,000	d. c.	....	....	32	B. c. r.
B. & M.	1	Coach	9-1931	Ice	R. B. Engrg. Co. and B. & M.	None	1	4	Flat belt	Body	Ice	Edison	340	d. c.	....	....	32	B. c. r.
C. & O.	1	Salon-coach	1933	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220-440	.....
	3	Lounge-diner	1933	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220-440	.....
	3	Diners	1932	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220-440	.....
	2	Club diners	1933	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220-440	.....
	3	Salon-coach	1932	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220-440	.....
C. & E. I.	2	Diners	7-1932	Ice	Safety C. H. & L.	None	1	4	Flat belt	Body	Water	Edison	375	d. c.	....	....	32	B. c. r.
C. & N. W.	1	Diner	6-1931	Mech.	Modine-Melcher	4-½ hp. motors	1	5	Flat belt	Body	Methyl-chloride	Exide	450	d. c.	....	....	32	B. c. r.
	4	Diners	5-1932	Mech.	P. C. & M. C.	Speed reducer	None	.....	.....	.....	Freon	.....	.....	a. c.	3	60	220	.....
C. R. I. & P.	4	Diners	6-1932	Ice	A. C. & F.	None	1	4	Flat belt	Body	Water	USL	450	d. c.	....	....	32	B. c. r.
Ill. Central	3	Chair	1932	Mech.	Westinghouse	Motor	1	15	10 gear and 1 V-belt	Truck	Freon	3 Exide	1,000	a. c.	3	60	220	.....
	2	Diners	1932	Mech.	Westinghouse	Motor	1	15		Truck	Freon	1 Edison	1,000	a. c.	3	60	220	.....
	2	Parlor	1932	Mech.	Westinghouse	Motor	1	15		Truck	Freon	3 USL	1,000	a. c.	3	60	220	.....
	2	Lounge	1932	Mech.	Westinghouse	Motor	1	15		Truck	Freon	3 Gould	1,000	a. c.	3	60	220	.....
	2	Comb.	1932	Mech.	Westinghouse	Motor	1	15		Truck	Freon	1 K. W.	1,000	a. c.	3	60	220	.....
M-K-T	3	Diners	5-1931	Mech.	Carrier	Motor	2	1—7½, 40 v. 1—10, 115 v.	Gear	Body	Ammonia	1 Exide 2 Gould	750	a. c.	3	60	220	.....
	2	Lounge	7-1933	St. eject.	Safety C. H. & L.	None	2	5 each	V-belt	Body	Water	Exide	1,000	d. c.	....	....	32	B. c. r.
	1	Business	8-1933	Mech.	Frigidaire	Motor	2	1—15 1— 5	Gear V-belt	Truck Body	Freon	Exide	2,000	a. c.	3	60	220	.....
	2	Lounge	7-1933	Mech.	1 Frigidaire 1 Westinghouse	Motor	2	1—15 1— 5	Gear V-belt	Truck Body	Freon	Gould-USL	2,000	a. c.	3	60	220	.....
Mo. Pac.	3	Diners	5-1933	Mech.	Frigidaire	Motor	1	15	Gear	Truck	Freon	Exide	1,000	a. c.	3	60	220	.....
	2	Lounge	4-1933	St. eject.	Safety C. H. & L.	None	2	5 each	Flat belt	Body	Water	Edison	900	d. c.	....	....	32	B. c. r.
Int. Grt. Nor.	2	Lounge	5-1933	Mech.	Westinghouse	Motor	1	15	Gear	Truck	Freon	Exide	1,000	a. c.	3	60	220	.....
St. L. B. & M.	1	Business	7-1932	Mech.	Modine-Melcher	5 Motors	2	4 each	Flat belt	Body	Methyl-chloride	Edison	900	a. c.	3	60	220	.....
	2	Diners	8-1933	St. eject.	Safety C. H. & L.	None	2	1—4 1—5	Flat belt	Body	Water	Edison	700	d. c.	....	....	32	B. c. r.
	2	Diners	6-1933	Mech.	Frigidaire	Motor	1	15	Gear	Truck	Freon	Exide	1,000	a. c.	3	60	220	.....
N. Y. C.	15	Diners	7-1932	Ice	P. C. & M. C.	None	1	4	Flat Belt	Truck	Ice	USL	450	d. c.	....	....	32	B. c. r.

* Battery charging receptacle only.

* Battery charging receptacle only.

Railroad	No. of cars	Type of cars	Date equipped	Type of system	Manufacturer of system	Compressor drive	Generators: No.	Generators: Capacity, kw.	Generators: Type of drive	Generators: Type of mounting	Refrigerant	Storage batteries: Make	Storage batteries: Amp.-hr. capacity	Outside power supply: Current Characteristics: a. c. or d. c.	Outside power supply: Current Characteristics: Phase	Outside power supply: Current Characteristics: Cycles	Outside power supply: Current Characteristics: Volts	
N. Y., N. H. & H.	2	Diners	7–1932	Ice	Airtrol-Rails Co.	.....	2	5	Flat belt	Body	Ice	Exide	1,200	d. c.	....	....	32	B. c. r.
	2	Diners	9–1932	Ice	Airtrol-Rails Co.	.....	2	5	Flat belt	Body	Ice	Exide	1,200	d. c.	....	....	32	B. c. r.
	1	Coach	9–1932	Ice	Airtrol-Rails Co.	.....	1	4	Flat belt	Body	Ice	Exide	325	d. c.	....	....	32	B. c. r.
	1	Coach	11–1932	Ice	B. F. Sturtevant Co.	.....	1	4	Flat belt	Body	Ice	Exide	325	d. c.	....	....	32	B. c. r.
	3	Club	8–1932	Ice	Airtrol-Rails Co.	.....	1	4	Flat belt	Body	Ice	1 Exide-2 Willard	325 and 335	d. c.	....	....	32	B. c. r.
	2	Diners	8–1933	Ice	B. F. Sturtevant Co.	.....	2	5	Flat belt	Body	Ice	Exide	1,200	d. c.	....	....	32	B. c. r.
Pennsylvania	1	Diner	6–1931	Ice	P. R. R.	.....	1	4.8	Flat belt	Body	Ice	Lead	600	d. c.	....	....	32	B. c. r.
	4	Diners	8–1931	Ice	P. R. R.	.....	1	4.8	Flat belt	Body	Ice	Lead	600	d. c.	....	....	32	B. c. r.
	5	Diners	1932–33	Mech.	.....	Motor	1	15	Gear	Truck	Freon	Lead	800	....	....	....	.....	.....
	1	Diner	6–1932	Mech.	.....	Motor	1	15	Gear	Truck	Freon	Lead	800	....	....	....	.....	.....
	1	MU-coach	8–1932	Mech.	.....	Motor	Motor driven from 25-cycle traction power supply				Methyl-chloride	.....	.....	....	....	....	.....	.....
	1	Coach	1–1933	Mech.	.....	Motor	1	15	Gear	Truck	Freon	Lead	800	....	....	....	.....	.....
	1	Coach	6–1933	Ice	.....	.....	1	4.8	Flat belt	Body	Ice	Lead	500	d. c.	....	....	32	B. c. r.
	1	Coach	7–1933	St. eject.	.....	.....	1	4.8	Flat belt	Body	Water	Lead	800	d. c.	....	....	32	B. c. r.
	42	Diners	1932–33	Ice	P. R. R.	.....	1	4.8	Flat belt	Body	Ice	Lead	800	d. c.	....	....	32	B. c. r.
	19	Comb.	1933	Ice	P. R. R.	.....	1	4.8	Flat belt	Body	Ice	Lead	500	d. c.	....	....	32	B. c. r.
	1	Diner	7–1933	Mech.	.....	Motor	1	20	Gear	Truck	Freon	Lead	1,000	....	....	....	.....	.....
	83	Coaches	1933	Ice	P. R. R.	.....	1	4.8	Flat belt	Body	Ice	Lead	500	d. c.	....	....	32	B. c. r.
Pullman Co.	92	Sleeping,		Ice	.....	.....	....	....	.....	.....	Ice	.....	.....	....	....	....	....	.....
	61	parlor,		Mech.	P. C. & M. C.	.....	....	....	.....	.....	Freon	.....	.....	....	....	....	....	.....
	86	lounge, lounge-		Mech.	B. & O.—York	.....	....	....	.....	.....	Freon	.....	.....	....	....	....	....	.....
	3	buffet,		Mech.	Frigidaire	.....	....	....	.....	.....	Freon	.....	.....	....	....	....	....	.....
	1	comb. &		St. eject.	Safety C. H. & L.	.....	....	....	.....	.....	Water	.....	.....	....	....	....	....	.....
	1	chair		Water evap.	.....	.....	....	....	.....	.....	Water	.....	.....	....	....	....	....	.....
St. L.-S. F.	6	Cafe-lounge	1933	Ice	Frisco R. R.	.....	2	4	Flat belt	Body	Ice	Lead	800	d. c.	....	....	32	B. c. r.
	4	Coaches	1933	Ice	Frisco R. R.	.....	1	3	Flat belt	Body	Ice	Lead	400	d. c.	....	....	32	B. c. r.
	4	Diners	1933	Ice	Frisco R. R.	.....	2	4	Flat belt	Body	Ice	Lead	800	d. c.	....	....	32	B. c. r.
	3	Lounge	1933	Ice	Frisco R. R.	.....	2	4	Flat belt	Body	Ice	Lead	800	d. c.	....	....	32	B. c. r.
Sou. Pac.	14	Diners	1932	Mech.	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Freon	Edison	450	a. c.	3	50—60	220—440	.....
Tex. & Pac.	3	Lounge	5–1933	St. eject.	Safety C. H. & L.	.....	2	5	Flat belt	Body	Water	Edison	900	d. c.	....	....	32	B. c. r.
	4	Diners	7–1933	St. eject.	Safety C. H. & L.	.....	2	1—4 1—5	Flat belt	Body	Water	Edison	910	d. c.	....	....	32	B. c. r.
Union Pac.	15	Diners	1932	Mech.	P. C. & M. C.	Speed reducer	1	4	Flat belt	Body	Freon	Edison and Edison lead	450	a. c.	3	60	220	.....
	3	Diners	1932	St. eject.	Safety C. H. & L.	.....	2	1—4 1—5	Flat belt	Body	Water	Exide	1,000	d. c.	....	....	32	B. c. r.
Wabash	1	Chair	1932	Mech.	A. C. & F.	None	2	1—4 1—10	Flat belt Gear and V-belt	Body	Freon	Exide	1,000	d. c.	....	....	32	B. c. r.
	2	Chair	1932	Ice	Wabash	.....	1	4	Flat belt	Body	Ice	Gould	500	d. c.	....	....	32	B. c. r.
	2	Chair	1933	Ice	Wabash	.....	1	5	Flat belt	Body	Ice	Gould	500	d. c.	....	....	32	B. c. r.
	1	Chair	1933	Ice	Wabash	.....	1	4	Flat belt	Body	Ice	Gould	500	d. c.	....	....	32	B. c. r.

Summary of Types of Systems and Refrigerants Used

Railroad	No. cars	Type of system: Electro-mech.	Direct mech.	Ice	Steam ejector	Refrigerant used: Freon	Water	Ammonia	Methyl-chl.
Alton	16	16	...	...	...	16	...	...	...
A. T. & S. F.	23	1	...	...	22	...	22	1	...
B. & O.	62	62	...	...	...	62	...	...	...
B. & M.	1	...	...	1	...	...	1	...	...
C. & O.	12	...	12	...	...	12	...	...	...
C. & E. I.	2	...	...	2	...	...	2	...	...
C. & N. W.	5	1	4	...	...	4	...	...	1
C. R. I. & P.	4	...	...	4	...	...	4	...	...
Ill. Central	11	11	...	...	...	11	...	...	...
M-K-T	8	6	...	...	2	3	2	3	...
Mo. Pac.	12	8	...	...	4	7	4	...	1
N. Y. C.	15	...	...	15	...	...	15	...	...
N. Y., N. H. & H	11	...	...	11	...	...	11	...	...
Penna.	160	9	...	150	1	8	151	...	1
Pullman	244	89	61	92	2	150	94	...	...
St. L.-S. F.	17	...	...	17	...	...	17	...	...
So. Pac.	14	...	14	...	...	14	...	...	...
T. & P.	7	...	...	...	7	...	7	...	...
Union Pac.	18	...	15	...	3	15	3	...	...
Wabash	6	1	...	5	...	1	5	...	...
TOTAL	648	204	106	297	41	303	338	4	3

Stresses in Welded Structures*

By Everett Chapman†

A discussion of the relation of welded joints to the structure; the value and importance of properly welded joints and some of the results of improper welding

THE science of structures is concerned with the economic distribution of elastic material to connect a load to its reactions over a reasonable length of time. Intimately associated with this broad subject are the various methods used to join the component members of the structure.

Any structure built of pieces must necessarily act as a whole under its applied loads. Joint efficiencies, therefore, determine the action of the structure. As the unit stresses are raised, high joint efficiencies become more and more important. As the loading cycle becomes more and more frequent, homogeneous joints become imperative.

Properly welded joints are more nearly homogeneous than any other type of connection between two pieces of material. Homogeneous joints are eminently desirable since they particularly affect the rigidity and fatigue performance of the structure.

Consider the two methods of supporting a load over a span, as exemplified in Fig. 1. The usual truss and

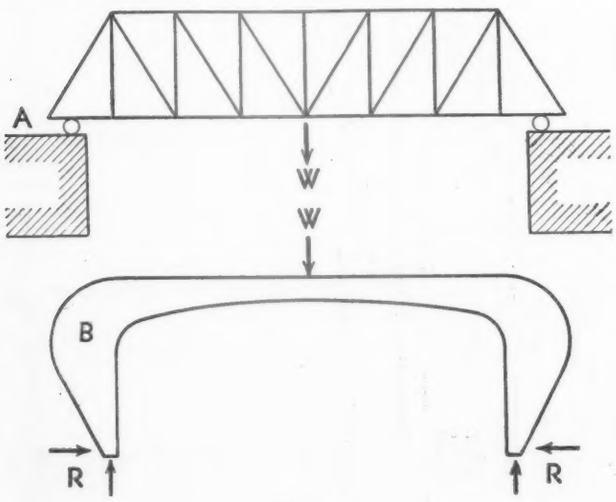


Fig. 1

abutment arrangement is essentially a three-piece structure, connected by pin joints. The rigid frame bridge is a one-piece structure in which the transition from horizontal to vertical members is distinguished by the fact that this apparent joint can transmit bending moments. In the one-piece rigid frame bridge, the bending moments are distributed uniformly over the entire structure. The vertical and horizontal members interact to redistribute the bending moments. When, as in this case, adjacent members interact through a rigid junction, the redistribution of bending moments may effect an economy of material running as high as 30 per cent. Considered broadly, the type of joint at the knee of the one-piece rigid frame bridge is the joint inherent in a properly welded design.

Two plates can be welded together so that the joints, as such, vanish. A homogeneous joint, or transition between two pieces of material, is a joint whose elastic behavior cannot be distinguished from that of the same configuration cut from a single piece of material. In the unattainable ideal, the maximum stress would have the same value as the average stress. The fact that this ideal can be closely approached in welded points has two implications for the structural designer.

First, as has been mentioned, is the fact that continuity can be taken into consideration in the design of gross structures such as bridges and buildings in which the moment of inertia of each member is much less than the corresponding constant for the whole structure. Welded design is eminently adapted to the curvilinear structures which result when continuity of elastic action is considered in the design. The second implication is that the behavior of the properly welded structure, under impact and fatigue load, is similar to that of a jointless structure as far as service life is concerned. The entire structure's resistance to severe loading conditions represents the thoroughly consolidated resistance of its components.

Homogeneous Welded Joints

A homogeneous joint has two characteristics. First, the material comprising the joint must have uniform physical properties from point to point; it must not have been damaged in any respect by the fabricating process. Second, the distribution of stress throughout the joint, from point to point, should be of maximum uniformity.

With a homogeneous joint of the desired characteristics, the two members are joined in such a manner that neither the elastic action nor the plastic action of the composite is distinguishable from the action of a single piece.

Three factors control the two desired characteristics of the homogeneous welded joint.

First, the parent metal is damaged by the extreme heat of the welding operation. Fig. 2 shows the transition zone between weld metal and 0.40 per cent carbon base metal. The large grain size is indicative of the high temperature to which the parent metal has been raised by the heat of the arc. The metallic heat path to the body of cold parent metal forms an excellent thermal sink, and the resulting rapid heat flow away from the weld thoroughly quenches the heated zones around the weld. The net result is a zone of highly overheated and quenched material adjacent to the weld. The severity of damage in this zone is a particular function of the carbon content of the parent metal, or more generally, a function of the air-hardening ability of the steel. This damaged zone, whatever its extent,

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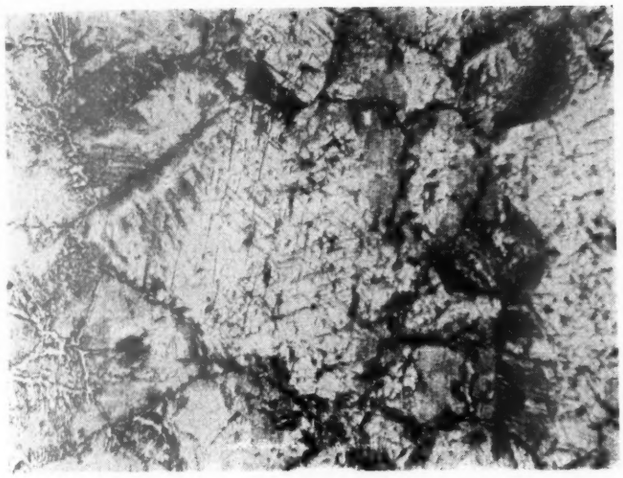


Fig. 2

represents a discontinuity in physical properties, since the large, overheated grain is decidedly weak in resistance to fatigue and impact. In addition, the hardened micro-constituents, due to the quenching action, are very strong, but they lack the ductility necessary to compensate for the thermal stresses to which the piece is subjected in the welding operation. The joint may crack through the damaged zones during fabrication. This phenomenon may be carried over into the service behavior of the structure if the damage is not corrected.

Second of the factors controlling the production of homogeneous welded joints is the design of the joint itself. It is the rule rather than the exception that stress concentrations of a very severe nature may exist in the joint. Fig. 3 shows the heterogeneous stress

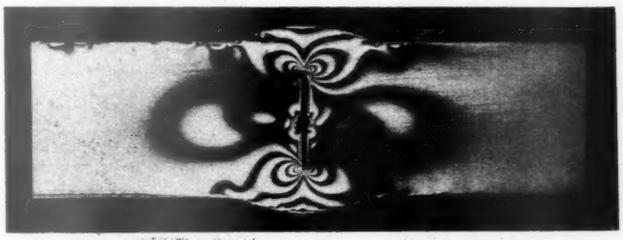


Fig. 3

condition which exists in an improperly designed welded joint. This photo-elastic study represents a loaded butt joint between two pieces of metal of equal thickness. The two welds, deposited from each side, did not meet at the center. The unfused portion forms an internal boundary which produces an extreme variation in stress over the joint. At the end of this crack, the stresses are very high. In addition, intermediate high stresses exist at the ends of the reinforcements which are usually, and vainly, applied in order to strengthen this type of joint. Such reinforcements are effective only under static load. But under impact or fatigue loads, the changes in contour at the ends of the reinforcements introduce additional stress maximums.

Third of the factors influencing the production of homogeneous welded joints is the element of residual stress introduced in the structure through contraction of cooling weld metal. Little is known of the direction or magnitude of these thermal stresses. However, there is direct evidence that the residual stresses, in many cases, may exceed the yield point of low carbon steel. When a known service load is superimposed on a structure which is already loaded by residual stresses in an indeterminate manner, the elastic conditions which exist from point to point are highly chaotic. In addition to the elastic chaos that residual strains may produce in a welded structure, severe warping will occur when the strains are relieved, either in the machining operation or by a gradual creep over a period of time.

Results of Improper Welds

Fig. 4 represents graphically the abortion which can result from the improper execution of a welded joint. This joint is far from homogeneous. The physical

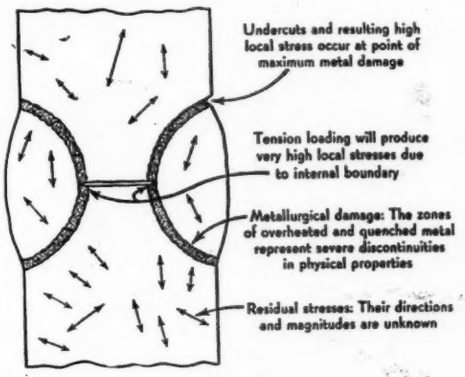

Undercuts and resulting high local stress occur at point of maximum metal damage
Tension loading will produce very high local stresses due to internal boundary
Metallurgical damage: The zones of overheated and quenched metal represent severe discontinuities in physical properties
Residual stresses: Their directions and magnitudes are unknown

Fig. 4

properties are not uniform from point to point, since there are zones of badly damaged metal. The stress values throughout the joint, when loaded, vary tremendously from point to point, because, in addition to the stress concentrations which exist at internal and external boundary discontinuities, the unknown residual stresses add to the concentrated load stresses, and thus produce utter chaos.

Whenever a welded joint, whatever its type, functions in a non-homogeneous manner, one or more of three destructive factors are operating—sharp changes in contour, damaged material, and pre-loading. For

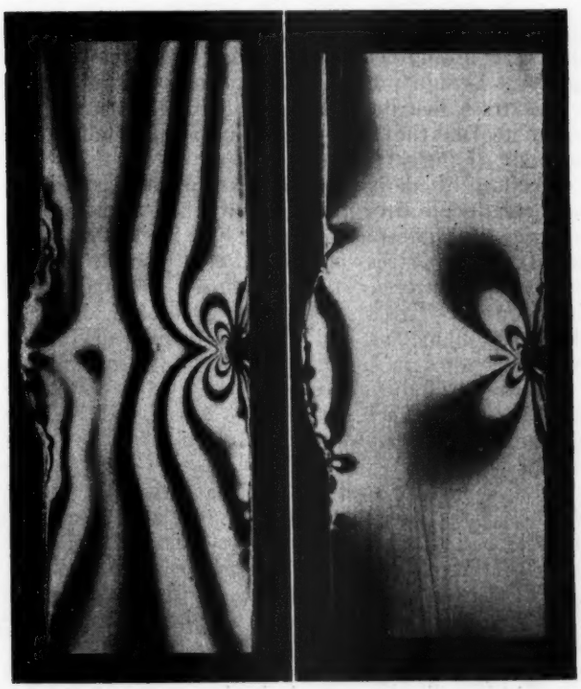


Fig. 5

example, Fig. 5 represents a stress distribution usually found in a weld made from one side of a plate. Such welds frequently introduce ragged contours, since the form of penetration of the weld metal cannot be completely controlled from one side. Where the design of the structure is such that welding from both sides is impractical, the use of backing-up strips permits the production of a compromise contour which is at least predictable.

Fig. 6 shows a failure resulting from a slovenly job of welding. The fatigue crack centered about the stress concentration produced by an extraneous bit of weld metal carelessly left by the welder to project from an important boundary of the structure.

Correction of the destructive factors which are present

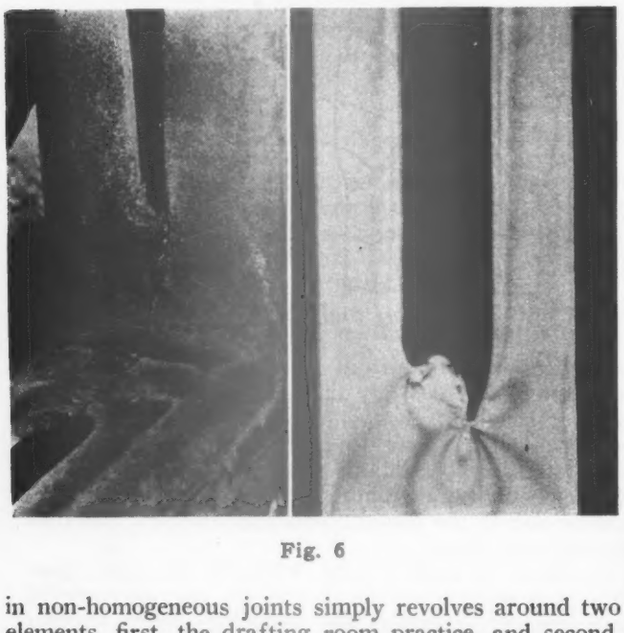


Fig. 6

in non-homogeneous joints simply revolves around two elements, first, the drafting room practice, and second, heat treatment.

As it is concerned with the design of the joints, drafting room practice must be carefully supervised to insure that no defects are allowed to creep into the structure. Design practice can no more afford to neglect the stress distribution in the joint than it can afford to neglect the stress distribution throughout the gross body of the structure.

Correction of damage to parent metal necessitates a heat treatment after the structure has been welded. The series of photo-micrographs, Fig. 7, illustrates the effect of welding, stress-relief, and treatment at the two critical temperatures, of two pieces of steel of different carbon content. All the photographs in Fig. 11 were made at 100 diameters, and etched with nital. The first picture represents the as-rolled condition of 2-inch plates. All the other pictures were taken on the very edge of the weld metal and illustrate the effects which occur in the parent metal. In the as-welded condition, it is seen that the parent metal in the case of 0.40 carbon steel is in a martensitic condition, while the 0.24 carbon steel shows evidence of the original austenite with troostite forming at the grain boundaries. It is to be noted also that the grain has been enlarged considerably. The probable characteristics of these two zones are extreme brittleness, no ductility and a general weakened condition due to the large grains. With such characteristics, these zones cannot absorb any energy, as they would be called upon to do in the case of an impact, and, furthermore, they have no self-relieving properties under thermal stresses because of their lack of ductility.

The effects of the usual stress-relieving treatment at 1,200 deg. F., followed by a furnace cool, are illustrated in the third group of two pictures. The temperature 1,200 deg. F., is usually considered sufficient for stress-relief, since at this temperature, ordinary low carbon steels have a yield of only about 2,000 lb. per sq. in. This means, of course, that any residual stress greater than 2,000 lb. per sq. in. will produce plastic deformation, and will therefore, vanish for all practical purposes. The pre-loading which was introduced by the contracting weld metal has been removed. However, 1,200 deg. F., if held for a proper length of time, will serve to break down the harder micro-constituents which are formed in the damaged zones. It will not, however, refine the grain, since the carbon does not go back into solution at this temperature.

It is also to be noted, then, in the third group of two pictures delineating the 1,200 deg., F. treatment, that the martensitic and troostitic phases in the two steels have been broken down to what is probably a finely divided sorbite and it is reasonable to suppose that the residual stresses after this treatment are under 2,000 lb. per sq. in.

Experience indicates that welded structures which have received this treatment will retain their shape during machining and indefinitely thereafter. Treatment at 1,350 deg. F. partially refines the grain, while the treatment at 1,650 deg. F., followed by cooling in still air, represents the maximum degree of refinement that can be obtained. Furnace cooling from 1,650 deg. F. is rarely practical since light-weight, high-duty structures may suffer severe distortion in the furnace due to their

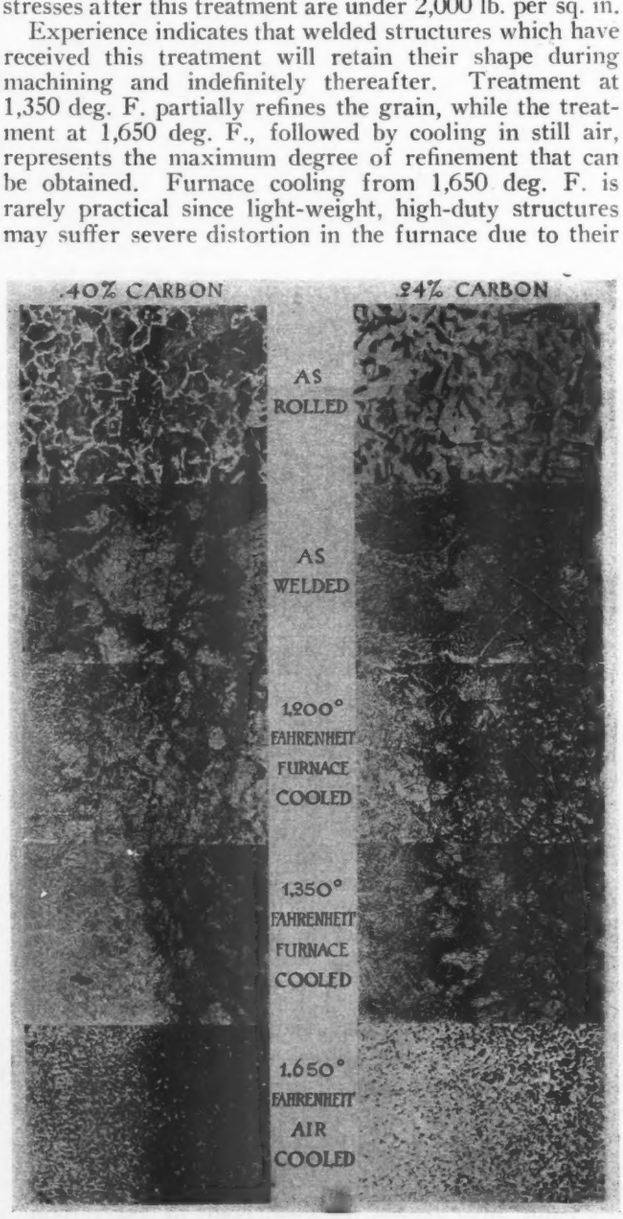


Fig. 7

own weight. The practical compromise that represents the best commercial practice is, therefore, a soaking treatment for one hour per inch of maximum thickness at 1,200 deg. F., followed by a slow furnace cooling. Under more rigorous service conditions a gain can practically be effected by raising the temperature to 1,400 deg. F., at which temperature the grain undergoes partial refinement.

The importance of keeping the carbon content of the steel in the lower ranges is graphically represented in the series of micro-photographs. The local damage done to the higher carbon materials more than offsets the higher average properties which they represent. It is through specifications of carbon content that the welding of large structures such as bridges and ships, which cannot be annealed in a furnace, will become practical. However, even where metallurgical damage has been minimized in this manner, the problem of stress relief is not solved. As more is known of the nature of residual stresses, mechanical peening will offer a compromise solution which will enable the full possibilities of welded construction to be realized by the designer. The carefully executed ideal, in which contours have received proper attention and which has been properly heat treated, need have a lower factor of safety than any other type of construction: it is more predictable. As the service duties increase and more and more is demanded of the available structural materials, the factor of safety must be reduced. Modern transportation trends are imposing high duties on available structural materials. Careful design and selection of materials are the only path to uniform stress, one piece structures. In such structures, the joint as an entity must vanish. The behavior of a properly made welded joint under any kind of load or load cycle cannot be distinguished from a single piece of rolled steel.

Walworth Builds A.R.A. Standard Valves

IN 1932 the American Railway Association, Mechanical Division, adopted specifications for standard globe and angle valves for steam locomotive service for 300 lb. pressure making the recommendations effective August 1, 1933. The purpose of the standard valve is to insure absolute interchangeability of parts regardless of the valve company producing the valve. The illustration shows such a standard valve as manufactured by the Walworth Company, New York, which is now producing the 1¼-in. size. Other sizes will be in production in the near future.

The specifications call for the manufacture of the body of steam bronze; the bonnet, bonnet ring, stuffing nut and disc nut of steam bronze or forged brass; the inside-screw stem of rolled brass rod or forged brass; the outside-screw stem of stainless steel; the seat ring and disc of copper-nickel alloy having a Brinnell hardness of not less than 100; the gland and handwheel-nut of free-cutting brass rod or forged brass and the handwheel of malleable iron. The standards adopted include the material specifications, globe and angle valve assembly, dimensions for inside and outside screws, union ends, markings and the details of every part.

The valve body, either globe or angle, fits the inside-screw or outside-screw yoke bonnet; that is, if it is desired to change a valve in service, from one type to the other it can be done without removing the valve from the line. Likewise, if it is desired to change the discs and seats from the regular type to the plug type, this can be done. The plug type discs are generally used on throttling service.

Two types of A. R. A. standard globe valves manufactured by the Walworth Co.

The principal features of the A. R. A. standard valve are interchangeability, due to close tolerances of manufacture, oversized stems and generally rugged construction.

"CITY SLICKERS" MAKE A SALE.—Three suave gentlemen who probably got their start in life by selling the Brooklyn bridge and the New York post office to gullible visitors from the country put in a good day's work recently at Denison, Tex. They sold the Denison station of the Missouri-Kansas-Texas to an unsuspecting citizen of Waco, Tex. For the station and "one-third of the proceeds from the sale of tickets to the Century of Progress in Chicago," the victim paid $1,100.

* * *

A 45-ton, 170-hp. gas-electric locomotive built by the Atlas Car & Manufacturing Company, Cleveland, Ohio, for service at the U. S. Navy airship station at Sunnyvale, Cal.

EDITORIALS

Supervision Challenged

"Too often," writes a correspondent, "bad conditions in handling traffic are charged to the men, when as a matter of fact the supervisor is the one at fault. It has been my experience that ninety-nine per cent of the men under my jurisdiction will do the work as I wish it to be done; in order to realize my wishes, however, I must get in personal contact with the individual who may be at fault."

If this is true, then successful supervision depends largely upon the ability of the supervisor to educate and properly train the men under him. He must not only know how the job should be done, but even more important than this, he must be able to teach and train the worker exactly how to do it. How much consideration has been given to teaching ability in selecting supervisors, or how thoroughly do the supervisors understand the importance of approaching their problem in this attitude?

New kinds of equipment are being introduced on the railways, the proper care and maintenance of which will require a thorough knowledge and understanding of its construction and operation. It may be necessary to work to closer tolerances than on the older types of equipment, or the design of the parts may be such as to require new and improved practices and facilities for their care and maintenance. Obviously, under these conditions the supervisors and the workers must put forth special efforts to equip themselves for handling the new facilities, if they are to make good on the job.

To complicate conditions still further, the working forces have been greatly reduced and more or less disorganized under the stress of economic conditions. Apprentice instruction in some instances has been neglected, if, indeed, any apprentices are still on the job. It is significant that under normal conditions the younger men, trained under modern apprenticeship methods, have in many instances made exceptionally good records because their training fitted them to take care of new equipment or meet new conditions, to which the older men with their more limited training could not adapt themselves.

Mechanical department officers are now faced with the problem of rehabilitating their organizations and getting ready for an amount of business in 1934 which promises to surpass considerably that of the past two years—the trend, at least, is strongly in that direction at this time. This will undoubtedly place a heavy load upon the shoulders of the supervision. The supervisor must study hard to keep ahead of the game, so that he can thoroughly and properly train the men under his direction, and at the same time must occupy himself with the difficult task of rebuilding his organization.

Incidentally, that railroading is worth while and that it still possesses a certain amount of romance and challenge, is indicated by the following quotation taken from a letter written by the chief executive of a large railroad to a young man who was desirous of securing information about the possibilities in the railroad field. "It is difficult," said the chief executive, "to conceive of any development that might come in a lifetime that would render railroads materially less essential than they are now to the economic life of the nation. It naturally follows that there will continue to be railway work to do. . . . The railroads have completed the task of pushing out the frontiers of American civilization, but there are new tasks in the refinement of the art, the development of new methods and devices, which offer a stirring challenge to the men of pioneering spirit."

Here, at least, is an encouraging note which should be a real inspiration to the officers and supervisors charged with rebuilding their organizations under present conditions. The emphasis, however, upon "new tasks in the refinement of the art, the development of new methods and devices," must not be overlooked. The success of the railroads will depend to a very great extent upon the ability of the executives and supervision to meet these new demands, which are far more complicated, although possibly less spectacular, than those with which they have been confronted in the past.

Air Conditioning Is Established

Competition in passenger business, keen at any time and particularly so during the past five years, has forced the railroads of the United States to develop many improvements in services in an effort to win back some of the lost traffic. There were those who were skeptical, when air conditioning was first suggested as a means of increasing passenger comfort, as to the advisability of such a program under existing economic conditions. The results of over three years of development by the railroads and the manufacturers of air-conditioning equipment have more than justified the efforts of those who pioneered in this work. Where three years ago air conditioning was in the experimental stages, today it is an established part of the equipment on many of the finest trains in the country.

Some idea of the progress that has been made in this field may be had from the statistical data concerning air-conditioned passenger cars which appear on pages 48 and 49 of this issue. It will be seen that during the past three years 21 roads have equipped 404 cars in addition to 244 cars equipped by the Pullman Company, making a total of 648 air-conditioned cars in the United States on December 31, 1933. It is a coincidence that there is an almost equal division with reference to types of systems between the mechanical systems—either direct or electro-mechanical—and those using ice; 310 cars being equipped with the former and 297 cars with the latter systems. Of the 310 cars equipped with mechanical systems 303 use Freon as a refrigerant, four use ammonia and three use methyl-chloride.

One of the really encouraging things about this development in a new field is that it was carried out during years when expenditures for railroad equipment and improvements were being held to those items which might be classed as absolute operating necessities, and apparently, having had to force its way through such economic handicaps, it now bids for a very definite place

in the railway equipment field. Within the past two months, and particularly since the first of this year, there has been a great deal of activity in air conditioning. Already announcement has been made of programs for equipping 634 cars—almost as many as in the past three years—and unconfirmed reports indicate the possibility of between 400 and 500 more cars being added to this list.

The question of whether or not the railroads are to make extensive use of air conditioning has been answered. The problem from now on is one of establishing the best practices for operation and maintenance.

Rehabilitation Begins

After eleven months devoted to the development of political measures for hastening national industrial and commercial recovery, results which first began to appear in the railway field in December have gathered headway during January. Orders have now been placed for 30 steam locomotives, over 19,700 freight cars and 159 passenger cars, which represent the major portion of the equipment to be financed out of the allocation of more than $200,000,000 which has been made for the railroads from the $3,300,000,000 fund at the disposal of the Public Works Administration. These orders, and orders for rail for which over $50,000,000 has been set aside, probably mark the largest single effort toward "priming" the capital goods industry which has been made since the administration at Washington gave evidence that it was aware of the importance of these industries to the success of its plans for effecting recovery by artificial stimulation. Both the freight- and passenger-car orders are the largest placed in any year since 1930. They amount to about 1,100 more freight cars and nearly two times more passenger cars than were ordered during the past three years.

In addition to the new equipment which is being purchased, arrangements are also under way for the repairing and rebuilding of over 1,000 locomotives, about 30,000 freight cars and over 1,100 passenger cars, to be financed from the $200,000,000 allotment to the railroads.

These measures set the stage for industrial and commercial activity which will feed more than $200,000,000 through channels which will direct it into the hands of thousands of men who would otherwise remain unemployed, perhaps for months to come. These men in turn will spend their newly acquired incomes for the discharge of debt, for rent, food, clothing, services and some luxuries, which will broaden the base of the demand for the products of many industries.

The amount involved is too small by itself to effect a permanent return of prosperity to the builders of railway equipment and the manufacturers of materials purchased by the railways. Coming at the beginning of the second year during which the forces of recovery have outweighed those tending to prolong and deepen the depression, however, there is good reason to believe that they mark the beginning of a healthy demand which will be felt for many months to come. Indeed, one railroad has already ordered 18 passenger cars, to be financed on its own credit, in addition to those which are to be financed from P. W. A. funds.

It is a significant fact that the total number of locomotives on the lines of the Class I railways do not exceed the number which were in active service at times during 1928 and 1929. The number in serviceable condition during the latter part of 1933 was about equal to the number in active service during the first half of 1931.

From April to October, 1933, the monthly road-locomotive miles increased from 60,000,000 to 70,000,000. A further increase of about 12,000,000 would restore locomotive mileage to the early 1931 basis, when all the locomotives now serviceable would be busy and any reserve would have to come from the accumulation awaiting repairs. Such an increase in business, restoring weekly car loadings to well toward 800,000, which may very readily take place during the present calendar year, will require an increase in maintenance activities which will tax railway equipment repair facilities. Equipment repairs have been falling behind steadily for the past four years, bringing the time constantly nearer at hand when railway operations, even on the present low level, can scarcely be maintained without an increase of maintenance activity, and to this will be added the load of deferred repairs on all classes of equipment, amounting to upwards of half a billion dollars, which will have to be caught up rapidly if increasing traffic is to be handled successfully.

Following the return of the railroads to private operation by the United States Railroad Administration in 1920, the railroads faced an equipment situation comparable with that with which they will have to deal during 1934. In order to meet the upturn of business which followed the depression and shopmen's strike of 1921 and 1922, they found it necessary not only to employ their own shop facilities to their utmost capacity, but also to place a large amount of equipment in the plants of the builders and other contractors for repairs and rebuilding. Whatever justification there may have been for following this policy, few railroad men would wish to repeat it in the light of that experience. The best way for the railroads to utilize the builders' facilities is for the production of new cars and locomotives which at the present time can be used to save a portion of the half billion dollars of deferred maintenance and to reduce the normal maintenance expenditures for at least three or four years. The economics of replacement vs. heavy expenditures for deferred maintenance should be given careful study before formulating complete rehabilitation programs.

Smoke Is Unnecessary

It is impossible to estimate the damage which is done to the health of people living in towns and cities by smoke and gases which pollute the air. It would be difficult, also, to estimate what it means, even roughly, in damage to buildings and their furnishings, and the costs of cleaning the furnishings and also the clothes we wear. It is likewise impossible to estimate the effect of dirty and dingy surroundings upon the mental attitudes and happiness of people who must live a large part of their lives in congested industrial and commercial centers.

The communities in New Jersey, across the river from New York City, contain a large number of industries and railroad terminals, and the entire metropolitan section was affected by smoke from these sources, depending upon the direction of the wind. Three years ago the

authorities in Hudson county, N. J., established a department of smoke regulation, Stevens Institute of Technology at Hoboken, co-operating in the establishment of this department. The results which have been secured in the past three years are really remarkable and should be an inspiration to all those who are interested in the elimination of the smoke nuisance. Smoke Abatement Engineer William G. Christy, in his recent annual report, estimates a reduction of 90 per cent in smoke violations on all classes of fuel burners, equivalent to about 85 per cent actual reduction in smoke density over the three-year period.

One reason why it has been possible to make this record is the fact that the elimination of smoke is evidence of good combustion and correspondingly lower fuel costs, and earnest efforts have been made to educate the public to this truth. Of special interest to railroaders is the fact that of 10,388 stack readings of locomotives operating in Hudson county during 1933, only 330 violations were noted. "Using the standard Ringelmann chart as the basis for measuring smoke," said Mr. Christy, "the railroad smoke density averaged 3.45 per cent for the year 1933, a reduction of 86 per cent since the smoke department began to function in may, 1931."

This report, reaching us just as we were going to press, is of special interest at this time because of the interview, entitled, The Locomotive Smoke Nuisance, which will be found elsewhere in this issue.

Cross-Counterbalancing

On another page in this issue will be found an article dealing with cross-counterbalancing which is a paper presented by Lawford H. Fry at a session of the Railroad Division during the annual meeting of the American Society of Mechanical Engineers last December. In two respects this paper goes farther in mathematical exactitude than it has generally been considered necessary in practice, first, in the analysis of the weight and location of the revolving parts to be balanced, and, second, in the correct location of the final counterbalance, including the weight to be added for reciprocating balance. The author's analysis shows that a lack of exactitude in both of these respects may appreciably change the result when the maximum rail and axle loads from the sum of static weight and dynamic augment must be kept within close limits.

With the increasing attention which is being given to high speeds and the already well established need for relatively high-speed operation of locomotives with heavy axle loadings, the need for close control of the maximum axle and rail loadings caused by the dynamic augment from the overbalance requires close attention to the details of counterbalancing. The refinements which Mr. Fry points out add little to the complications of the calculations for crossbalancing and require only the location of the center of gravity of the eccentric crank in addition to the weight which is required in any counterbalancing calculation. The results clearly justify the additional refinements.

In next month's issue will appear the second part of Mr. Fry's paper in which will be found a complete set of calculations arranged systematically in the form of a work sheet for a complete cross-counterbalancing analysis.

NEW BOOKS

MECHANICAL WORLD YEAR BOOK. *Published by Emmott & Co., Ltd., 31, King Street West, Manchester, 3, England. 362 pages, 4½ in. by 6½ in. Price, 1/6 net.*

The 1934 edition of the Mechanical World Year Book includes a comprehensive and up-to-date section on metals and alloys and, in general, metallurgical matters as they concern engineers. The section is illustrated by photo-micrographs and explanatory sketches. Another new section provides data and information invaluable to machine-tool users and machine-tool makers alike. A third new section deals with sheet-metal press work.

ARC WELDING HANDBOOK. *By C. J. Holslag, chief engineer, Electric Arc Cutting & Welding Company, 152 Jeliff Avenue, Newark, N. J. 275 pages, 5 in. by 7½ in., illustrated. Bound in cloth. Price, $1.50.*

This is the seventh edition of the book, first published in 1918. It has been brought up to date with chapters on shielded-arc welding, annealing and new types of electrodes. An explanation has also been added of fusion in the form of a new theory of why steel and other metals hold together. The book has been reprinted in Spanish, French, Japanese and English, in the latter because American idioms and technical nomenclature are inapplicable in the United Kingdom.

AIR CONDITIONING. *By James A. Moyer, state director of university extension in Massachusetts, and Raymond U. Fitts, assistant professor of mechanical engineering, Tufts College. 390 pages, 6 in. by 9 in., illustrated. Published by the McGraw-Hill Book Company, Inc., New York. Price, $4.*

The book deals specifically with air-conditioning principles, ventilation requirements, air filtration, cooling methods, refrigeration for air conditioning, properties of refrigerators, types of equipment, temperature and humidity control, design of systems and auxiliary applications. Railroad passenger cars, office buildings and factories are among the practical applications discussed. While the chapter on railroad passenger cars does not furnish new or precise information to the railroad man who has followed this development during the past two years, the book should be of value to one who wishes to acquaint himself with the underlying principles and the ramifications of air conditioning.

COST AND PRODUCTION HANDBOOK. *L. P. Alford, editor. Published by the Ronald Press Company, New York. 1,544 pages, 5 in. by 7½ in. Bound in imitation leather. Price, $7.50.*

The material in this book is the product of eighty contributing and consulting editors, assembled and arranged under the direction of L. P. Alford. The contributors were chosen because of their practical and authoritative connection with some phase of cost accounting, industrial management or production engineering. The text is divided into 28 sections or chapters, beginning with a general study of business and production statements and reports and continuing through the entire range of the production problems involved in industrial management. Within this category are included sections dealing with machinery, small tools and labor, as well as those dealing with the routine phases of industrial management. Several sections are devoted to various phases of costs and cost accounting. Others deal with the principles of industrial management, operating charts and symbols and classifications. The information in each section is systematically broken down and arranged under numerous sub-headings, and there is an index of 45 pages.

THE READER'S PAGE

Heating 18-Car Trains—A Correction

In a letter appearing on page 18 of the January issue entitled "Heating 18-Car Trains" the formula given should have been shown as follows: $S=N^{(4.31-N/12.5)}$ wherein the value in parentheses is the exponent of N.—EDITOR.

Dave and Alec Called on the Carpet

TO THE EDITOR:

In the January issue of the *Railway Mechanical Engineer* there appears on pages 20, 21 and 22, under the heading "With the Car Foreman and Inspectors," a fool and jester article "Alec and Dave Are Back Again."

This tommyrot from the author of "Alec and Dave" has taken up space in your valuable publication which might have been better utilized. There is nothing educational or inspiring to be gained by reading it.

I am wondering if the author made any attempt to find out how far the argument between Alec and Dave differs from the established method of interchanging cars under A. R. A. rules. If he does not know the rules, he should ask any up-to-the-minute car inspector who will inform him the rules governing the interchange of cars thoroughly covers the very case he has used as the basis of his story.

The fact that cars are interchanged in a business-like manner under A. R. A. rules, particularly Rule 2, throughout the entire country—United States, Canada and Mexico—has entirely wiped out characters of the Alec and Dave type, if indeed they ever existed.

To think that a car inspector would pull a loaded car out of a train for a supposed loose wheel, the only indication being a spattering of oil on the axle at the wheel seat which was caused by a drip leaking from the contents through a crack or seam in the car floor is absurd and to mention it is an unjust attempt to reflect on the intelligence of the car inspectors of American railroads who are governed in cases of this kind by A. R. A. Rules 2 and 61 and paragraphs 116, 140, 142, 218 and 240 of the Wheel and Axle Manual.

There are cases where at the inside of the hub of the wheel an incrusted accumulation of oil and road dust is in evidence which may be taken as a condition indicating some imperfection in the wheel and axle fit, but not necessarily a loose wheel. (See A. R. A. 81.)

The inspector, however, uses his best judgment if a doubt exists as to the safety of allowing a wheel in this condition to remain in service. He does not return the car to the delivering line, as the author of Alec and Dave tells us, but instead he accepts the car, cards it to his shop and repair track for change of wheels in accordance with A. R. A. Rules of Interchange. This work is usually done with little or no delay of the car to the consignee.

There is no room for the Alec and Dave methods under A. R. A. rules which have been adopted after much thought and study of all subjects pertaining to car interchange. The mechanical officers of our railroads may justly take pride in accepting a code of workable rules which are understood and carried out intelligently by car inspectors in discharge of their duties, despite the fact that the author of Alec and Dave has attemped to class them as morons.

A CAR INSPECTOR.

Painting and Repairing Aluminum Cars

A reader asked two questions concerning maintenance practices on aluminum cars which are of sufficiently general interest to publish, together with answers which were supplied by the Development Division of the Aluminum Company of America.

Q.—What primer can be used on the interior aluminum surfaces of passenger cars that will adhere to the metal from eight to ten years as does the primer now in use for similar steel surfaces? A.—It is not so much the priming coat of paint as the preparation of the surface that will make the priming coat stick to aluminum surfaces. The surfaces on either the inside or the outside of the cars should be roughed up either by sandblast or wire wool so that crevices or holes of minute size are left on the surface in which the paint can anchor itself. All oil or grease should be removed by washing with a high volatile solvent, such as naphtha, and the priming coat applied as soon after the preparation of the surface as possible. The priming coat may be sprayed or brushed. A preferred primer for aluminum is one having inherent inhibitive qualities such as would be obtained by zinc or lead chromate. This tends to prevent the undermining of the paint film. It is also desirable that the paint have sufficient flexibility to stand a certain amount of weaving of the surface and that care be taken to see that it dries without cracking; in other words, that a continuous film is provided. There are a number of good primers on the market, such as zinc chromate, that should be good for ten years life if the surface is properly prepared. There are also some bakelites which, used as a vehicle and having zinc chromate and other solids mixed therein, will make an excellent aluminum primer.

Q.—What is the best method of repairing a hole in the roof of an aluminum car? A.—The best way is to apply a small patch over the hole and weld it with an electric metallic arc around the edge to make it tight. If welding equipment is not available, the patch can be applied with drive screws. In the latter case it is desirable to have a thin piece of tar paper, approximately 1/32 in. thick, between the patch and the roof sheet. In either case both the roof and the patch should be painted before assembly.

ENGINEMAN OF ROYAL SCOT HONORED.—William Gilbertson who will be remembered as the engineman in charge of the Royal Scot during its visit to the Century of Progress in Chicago last summer, was honored by King George on New Year's Day. He was awarded the medal of the Order of the British Empire for having piloted his train without accident over more than 11,000 miles of railway in the United States and Canada.

With the Car Foremen and Inspectors

Split and Cotter Keys

*By P. P. Barthelemy**

AN article entitled "Split and Cotter Keys" by the writer was published in the January, 1933, number of *Railway Mechanical Engineer*. With the advent of severely cold-weather conditions in a large part of this country and in Canada, the seasonal brake-rigging troubles, always at their worst in cold weather, are again with us. These failures are a constant source of operating trouble and car maintenance expense, and further comments on split and cotter-key troubles are again in order.

The accompanying pictures illustrate forcefully conditions that exist on a large number of freight cars. The split and cotter keys shown were removed chiefly from brake-hanger pins on a wide assortment of freight cars of both railroad and private-line ownership. They were in the general defective condition illustrated, except that in some cases some slight distortion from the in-place shape occurred in the removal. From their worn condition, there can be no doubt that they had been defective for a long time and in that condition had passed many inspection points. In several cases, there was evidence that the car had been on a repair track and had been permitted to leave without this bad condition having been corrected.

Of the three illustrations at the bottom of this page the one at the left shows cotters; the center, split keys with one wing worn off just below the eye or head and the other wing also badly worn; the illustration at the right shows a representative lot of defective cotter keys.

Practically all of these defective keys are very old, indicating neglect in renewal attention, and in too many cases the re-use of a key that had obviously already outlived its safe usefulness. Reclaiming old and worn split and cotter keys is very doubtful economy, as the time devoted to reshaping, in most instances, exceeds the very small cost of a new key; but what is by far of greater importance, each of these old worn and brittle keys re-used constitutes a potential failure and probable train accident.

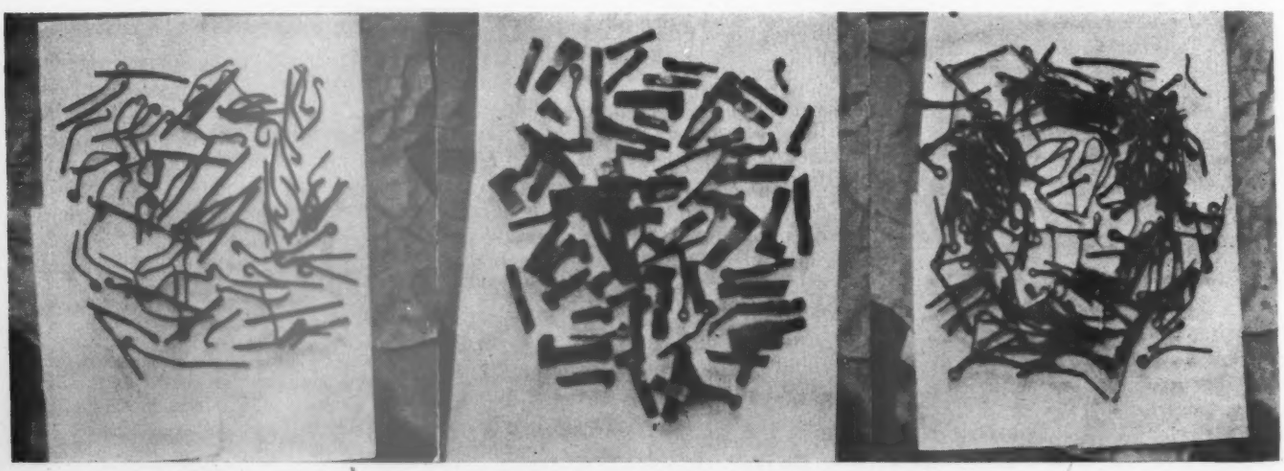
Another bad condition revealed in these pictures is the absence of a standard, resulting in the wide use of keys much too small for the pin hole and too small to provide the degree of security demanded. The length also varies, some of them being over 5 in. long. Over-length keys constitute a hazard in that in the rotation of the pin, the ends of the key may strike an obstruction in the hanger bracket and become straightened and the key lost. Some of the keys are very small; and in one case a short cotter was used through the eye of the main cotter to prevent the head dropping through the hole in the pin. No doubt many others of these small keys dropped through after very little wear and were lost. Some of the samples in these pictures were actually pulled through the pin hole. Occasionally we see even an example of the good old hay wire.

The flat split keys show an equally deplorable condition—neglect, re-use of old and obviously worn-out keys, use of keys made of very thin material, and, in some instances, keys made of scrap thin galvanized iron. Some of these conditions may, of course, be due to deferred maintenance, but in entirely too many instances, there is evidence of inattention and gross carelessness on the part of car owners, both railroad and private lines.

Good Split- and Cotter-Key Practice

There are a few important points that should be observed in connection with split and cotter-key applications, such as having holes in pins large enough to permit the use of keys of substantial size, and always using a key that practically fills the hole in the pin. Spread both wings, each about 45 deg. Re-use only keys

*Assistant master car builder, Great Northern.



Miscellaneous defective cotters and split keys removed from freight cars and suitable only for scrap

of proper size and in obviously first-class condition. Avoid the use of over-length keys. Loop brake hangers, that is, hangers without pins and cotters, should be used wherever possible. Open-type hangers should not be used on new cars nor with new truck side frames. Where the truck construction does not admit the use of the closed loop hanger, other means should be devised for protecting the keys and pins from excessive wear or loss.

Much of our brake rigging trouble is due to vibration rattle. Repairing these defects in so far as the renewal of rattle-worn parts is concerned takes on the nature of a locally-applied remedy and is, therefore, only of a temporary character. Obviously, rattle and vibration that will cause a cotter key to wear thin and a pin to wear half through are also harmful to other parts of the car, those of the truck in particular. It is, therefore, important to trace and locate the causes of these rattle conditions and see if we cannot do something about them. The conventional truck foundation brake arrangement is, for good reasons, hung from the truck frame, which is unprotected by springs. Therefore, all irregularities as between the wheel and rail are transmitted uncushioned through the truck frame to the brake hanger arrangement.

Some of the brake-rigging rattle wear is, of course, caused by vibrations of the shoe, particularly on the upgoing side of the wheel, but since the period of brake application is comparatively short and such applications are not ordinarily frequent, this accounts for only a small part of the wear. Rail joints and other irregularities in the track, and the unresilient road bed in very cold weather, will account for another measure of wear. Ordinary observation, however, discloses the fact that the condition of the wheels has more to do with excessive rattle than any other part of the car. Comby treads, flat spots, shell-outs, worn-through chill, worn out of round, are the chief wheel service conditions that cause pounding. Grinding out flat spots, except by grinding down the entire circumference of the wheel, is also bad as while it eliminates the sharp blow struck by the flat there nevertheless remains the low spot which causes a pronounced pounding harmful at any but very low speeds.

Comments on Wheel Defects, Grinding, Truck Springs, etc.

The pounding defect limit for freight-car wheels is, and for a great number of years has been, based roughly on the 2½-in. flat spot. The weight carried on the wheel has been greatly increased since the adoption of the basic 2½-in. spot. The wheel manufacturers, however, have kept pace with these advances so that the present wheel, with its greatly increased load, is even safer from failure with a limit flat spot than was the one in use when this limit was adopted, a high tribute to the progressiveness of the wheel manufacturers and the A. R. A. Car Wheel Committee. But we are equally concerned with the effect of these defects on the rest of the car, including the brake rigging, and on the lading.

The most important of all recent developments is the great increase in freight-train speeds. Certainly, cars having wheels with near-limit tread defects are not safe to handle in trains operating at some of the present high speeds. Should there not be a downward readjustment in the basic limits for tread defects on freight-car wheels? Would it not be a paying practice to grind the chilled-iron wheel to a perfectly true contour after mounting? Slight eccentricities in mounting and irregularities in tread surface would be removed, and it is reasonable also to expect such wheels to run longer before developing tread defects, and they would run even more smoothly than a turned steel wheel.

Are we not literally squandering money by trying to get every penny's worth of service out of our wheels at the expense of other parts of the car? The line indicating the development of tread-wear defects is not a straight one, but a curve that starts out slowly from the straight line and increases in sharpness of curvature as the defect wear progresses, being very rapid in the last stages. In other words, a comby or chill-worn wheel, for example, with defect to, say, 75 per cent of the condemning limit, has comparatively little mileage left in it since at that stage these defects increase very rapidly. The net service cost of the chilled-iron wheel per 1,000 miles is very low.

The effect of rattle and pound is indicated by excessive wear on the bolster and guides, on center and side bearings, by fatigued, cracked and broken spring planks, by abnormally early and severe fatigue in truck side frames and arch bars, by excessive hot-box trouble, excessive wear between journal-box and journal-bearing wedge, distortion of bearing surface of journal bearing, and by loosening of the lining from the brass shell.

Brake-beam safety hangers in the form of angles or bars, riveted or bolted to the spring plank, have not proved as effective in preventing loosened brake beams from dropping to the track as would be expected, chiefly due to rattle wear on the fastenings and subsequent loss of safety; it is an open question if the A. R. A. angle arrangement will fare much better.

How about truck springs? Has that problem been approached from the proper direction? Some of our cars have so much truck-spring capacity that when a car is empty or carrying a light load we do not get the proper cushioning effect, so that wheel shocks on the rail, not being properly cushioned, are much more severe than they should be, and for the same reason there is a repercussion of the shock on the supposedly sprung part of the car that is in a large measure transmitted back to the truck frame and its directly related parts and adjuncts. Truck-spring snubbers and other cushion devices and arrangements that provide ample protection with a minimum spring capacity are steps in the right direction.

Are there not other truck conditions of a more or less fundamental character in our present construction that may well be modified to provide a smoother running machine and thereby reduce or eliminate many of our troubles, including wear and tear on the parts of the foundation brake rigging?

PULLMAN VETERAN STILL CARRIES ON.—Like old soldiers, old railway coaches never seem to die; they merely fade away. At least, this is the thought expressed by the press department of the Canadian National in announcing the discovery that a 61-year-old Pullman sleeping car is now doing duty as a general storehouse on the western shore of Hudson Bay. The records show that this ancient Pullman was built in August, 1872, and was named the "Conway." It ran on the old Eastern Railroad of Massachusetts until 1880, when it was remodeled and given the new name of "Capitano." In its rehabilitated state, it boasted a barber shop and a bathroom. In 1904, "Capitano" was sold to some one who wanted a private car and at a later date it was again renamed, this time "Marlborough." From then on, it drifted from one place to another until it finally came into the hands of a railroad contractor and through him to the Canadian National, which transformed it into a business car for the chief engineer engaged in the construction of the Hudson Bay Railway. The car has now outlived its usefulness even for that purpose and, a mere shell of its former self, it serves as a storehouse on the railway at Canada's most northern port, Churchill.

Alec and Dave Fix a Brake Beam

By T. J. Lewis

LAST week was a bad week for Alec. He must have lost his rabbit foot or had a black cat cross his road. If it wasn't one trouble it was two. His work stayed "gummed up" all the week and even Dave got the better of him on every deal.

To begin with, he missed seeing a defect card on a car on which repairs had already been made. That, of course, was an awful crime, since it had been caught by an inspector up the road; but the blamed things are so unusual these days and, besides, they are often so inconveniently located, that there is little wonder that a fellow misses one occasionally. Then, a car on which he had cleaned, oiled and tested the air brakes had been pulled off the repair track, put in a "hurry up" train and left town without being stenciled, all while Alec was at lunch. Further, if a car inspector wants to get into real hot water, just let him have a hot box on a passenger train. Alec had two in one day. It just seemed that if a fellow was to get by at all he'd have to go with his fingers crossed all the time.

All these matters were dragging themselves slowly and sorely across Alec's mental vision the other morning as he finished his interchange work and started to the rip track. Just then Dave stepped out from behind a cut of cars on his own interchange and said "Hello, Alec."

Alec said, "Hello, yourself. How are you feeling, Dave?"

"All right, I reckon," said Dave. "Hadn't really felt of myself to find out."

Dave seemed to be in no particular hurry, so he went along with Alec until they came to Alec's rip track, then gave the cars in the shop the "once over" as they went. Soon they came to one of Dave's cars that had been shopped for a brake beam. The nut had lost off the brake beam truss rod and the beam had pulled some of the bow out of it which made the rod too short.

Alec said he didn't think he had a beam of that sort and was not sure yet how he would manage it.

That statement by Alec gave Dave a thought and he set in at once to see if he couldn't get around Alec to keep him from billing the car for a brake beam. So he became very mollifying and began to minimize the job of repairing the beam by saying "Why, Alec, I wouldn't think of going to the trouble of changing beams. I'd just put a nut on that truss rod, tighten it up good and let it go at that."

If Alec had not been feeling blue and all out of "sorts" he would not have considered Dave's proposal but, more or less thoughtlessly, he remarked: "I hardly think it's worth while, Dave. You see the end of the rod is back flush with the brake head now and I'd hardly be able to get a full nut on the rod."

Dave had noticed how indifferent Alec had seemed to be and took advantage of it to press his idea of saving his railroad a repair bill. So, taking care not to appear too keen, he set in to get around Alec in this way: "Just let off a few turns on the nut on the other end of that rod, Alec, and you can fix it right up. Then if you should need a little more 'set' in the beam, just slip a couple of running board saddles, or something like that, in between the back of the brake head and the spring plank and set a journal jack between that crosstie and the middle of the beam and you can jack all the 'hump' in that beam you want"; adding as an after-thought,—"chock the wheels, of course, to keep the car from rolling off the jack."

Alec was becoming a little irritated at Dave for his persistence, but took it for a natural feeling and found himself starting to follow Dave's suggestions.

"Entirely too much fiddle-faddle, Dave," Alec said, "I don't like the idea of so much banjo-work. I will let off on that other nut and if I can fix it that way, alright, if I can't, I'll change it and be through with it."

ALEC started one of his repair men to the tool house for a socket wrench and a nut, while he and the other man undertook to see what could be done about loosening the nut on the other end of the brake beam. When Dave saw them getting busy on the job he left, feeling a little mean about having persuaded Alec to undertake a job of that kind. Soon they had the wrench and nut and set to work and after the usual amount of pulling and tugging with just enough cussing to get by with that sort of a job, Alec found that he could not get a full nut on the truss rod. Then, as he was making a final effort, the wrench slipped and he barked three knuckles on the journal box. Then he threw down the wrench and proceeded to express his opinion of Dave for recommending such a job, of himself, or any other man for being bone-headed enough to undertake it.

But what would he do? He had no beam of that kind. As he threw the wrench down he realized that he would have to pick it up again. That did not dispose of the repair job on the car. It had to be man-handled and right away, too.

Going back to the car, he knelt down, leaned the wrench against the truck side and looked at the brake beam and just kept looking—looking for nothing in particular. Then the brake beam truss rod caught his eye. After staring at it a moment he shifted his glance quickly to the nut he had started on the end of it, took hold of the nut, then slipped his rule out and measured it. Yes, it was a 1⅛-in. nut alright, but that rod looked entirely too small. Reaching into his jumper pocket for his calipers, he calipered the rod and found it to be only one inch in diameter. That, of course, made it a No. 1 beam and so only scrap iron.

Calling to Jim, the car repairer, Alec said: "We'll have to rig up some sort of a brake beam for this job. This is an old No. 1 beam on here. It has a one-inch truss rod with the ends upset to make it big enough to thread an inch and an eighth."

Alec went over to the scrap bin and looked it over and called back to Jim, "Hey, Jim, here's an old scrap beam here with both heads worn out. We'll get it, and there's a couple of old second hand heads on the platform, get them, and we'll rig up something for it." Just then a freight extra came pulling in and, of course, Alec had to go to inspect it, so as he left he called over his shoulder, "You fellers go ahead, Jim, and fix it up the best you can, I gotta go now." They went ahead.

Dave happened to have it easy that day, very little work to do, so early in the afternoon he came "oozing" around to Alec's shack. Alec saw him coming and decided to "razz" him some and thus get an installment payment for those three skinned knuckles. Hunting out the billing repair card for the brake beam, he placed it on the top of the pile and laid the stack over on the end of his table-desk near where Dave always parked himself. True to form, Dave came "barging" in with a lusty "Hello, Alec," and plopped one long leg across the corner of Alec's table, crossed the other over it and asked, "How's business?"

"Alright, I guess, if anybody'd do it," Alec answered.

"Do what?" Dave asked, as his jaw dropped a little.

"Business, of course," Alec said, "what was you talking about?"

"Oh, Mr. Solomon, you been turning the emery wheel, or just the grind sto — Say! What the devil is this?" as his eye caught sight of the repair card.

"What does it look like?" Alec asked.

"Well," said Dave, "first rattle out o' the box, it looks like a helluva fudge to me."

"O yes, everything looks like fudge to you. I think you must have been brought up on it," Alec said.

Sure, Dave was not the man to be put off once he started to dig into a repair bill, so he continued:

"Really, Alec, you don't think you can charge for a brake beam just for the little work you did on that job, do you?"

"Well," Alec came back, "what do you expect me to do? All that work for nothing? Not on your life. And three barked knuckles to boot? Not me. I'm going to get paid for that job, whether you like it or not?"

"Nobody is going to object to you getting pay for what you do, Alec, but Rule 16 says 'Charges must be confined to actual work performed,' and all you did was to put a nut on that brake beam truss rod," Dave said, and continued, "I was there when you started the nut on."

"You was not there when that blamed wrench slipped and caused me to bark my knuckles on the journal box, was you?" Alec asked, the while gingerly petting said knuckles with his other hand.

"No," said Dave, "me being of a sort of religious turn, I'm glad I was not in hearing when that happened."

"'Sort' was well used there," said Alec, "but just how would you go about making a bill for that job?" he asked and went on "you know there is no provision in the rules for making a charge for repairing a brake beam on a car, nor is there any charge that can be made for just a one and one-eighth inch nut; so you think I should work on your blamed old car, put it in ship-shape and send it home to you free of charge, do you?"

"O, no," Dave answered, "there's no objection to you getting pay for what you do, but there is objection to you billing for what you don't do."

"Now see here," said Alec, "if I had taken that beam out and put another one in its place or if I had taken it out and put that nut on and put the same beam back, my charge of a second hand beam complete would have been correct, wouldn't it?"

"Sure it would," Dave replied.

"Well, what do you care whether I take the beam out to put the nut on or whether I put it on while the beam is still on the car?" Alec wanted to know.

"Don't make a bit of difference to me," Dave said, "it's my business to see, as far as I can, that when you bill our cars, you bill 'em according to the rules. Besides," he continued, "I didn't make the rules—I just try to work by 'em."

Alec saw that Dave was pretty well stirred up, so he decided to let up on him, so he said:

"Well, Dave, I was just trying you out on that rule, to see if you would be as contrary as usual, and I find that you will, so I'll tell you, I had to change that brake beam, because the defective one on the car was an old, out-of-date No. 1 beam and if I had changed it in kind, I would have got no pay for it and, not being overly fond of working and spending the company's good time for nothing, I just rebuilt a second-hand beam and put it on and made my bill accordingly, so you see the account is square after all.

Dave snorted, "Smart-Alec, huh? Well, since you've been so nice as to tell me all about it, let's just go out there and take a look at the whole job."

AS they passed the scrap bin, Dave had to stop and caliper the truss rod of the old beam to see for himself if Alec was right. That done he sauntered on over to the car and gave it the "once over," then came to the brake beam, stopped, looked at it, then went around on the other side of the car and looked again. Then he exploded:

"What the hell do you mean, Alec, by turning one of them brake heads bottom upwards? If you was going to do the job, why didn't you do it right?"

Alec, looking himself, saw what Jim had done, then he said:

"Well, I'll be damned!" But after a little consideration he said, "Why, Dave, here's what happened."

"Jim found that both of those old brake heads were right hand heads, so all he could do was to turn one of them bottom up'ards. Course it don't make any difference, it's a center-hung head anyway."

"Difference, hell!" Dave snorted, "all you think about is your damned repair bill. Second paragraph of Rule 16 says, 'Repairs to foreign cars must conform, in detail, to original construction,' with certain exceptions and that is not one of the exceptions. That brake head is bottom up'ards, Alec, it's just bottom up'ards, that's all. I'm going to contest your bill unless you correct that repair job."

Then Alec's dome cap went off.

"Bottom up'ards is it? Bottom up'ards! Well, what if it is? I reckon when you put in a pair of wheels you look to see if they're bottom up'ards don'tcha? Why, this old trap's 21 years old, stenciled here on the side, 'Built 1912.' It's been patched in every State in the Union and Canada to boot. Now you want to talk about 'original construction,' why the man that made it couldn't tell what the original construction was. Just take a look at the other end there, there's a whole brake beam some one has put on bottom up'ards. We just got it from you less than a week ago. It's only been up to Mallory with a load of lumber. We'er all lucky it made the trip." Alec's breath being exhausted, he stopped and looked at Dave.

Dave was stamping around the other end of the car with his hands rammed deep in his overall pockets and when Alec finished his "say" Dave was quiet and thoughtful for a moment, then raising his head, looked straight at Alec and said, "I'll tell you what Alec, let's go to the show tonight. There's a good one on at the Bijou."

After a moment's hesitation, Alec said, "Might as well, I reckon."

"Alright," said Dave, "I'll meetcha at the drug store 'bout 7:30." So saying, he turned and "ambled" off toward his own shack, softly whistling, "Meet me in St. Louis."

A New System of Cleaning Tank Cars

AN automatic, mechanical, tank-car washing machine, designed and built by the Pyrate Corporation, Portland, Ore., has been thoroughly tested during the past 12 months by the Union Pacific at Los Angeles, Cal., and the General American Tank Car Corporation at Chicago. The machine is used to apply chemicals to tank-car interiors automatically and mechan-

ically, providing cleaner cars at substantially less cost than by present hand-cleaning methods. It is estimated that the Pyrate system saves approximately 50 per cent in labor and material costs, also reducing by a similar amount the time which cars must be held out of service for the cleaning operation.

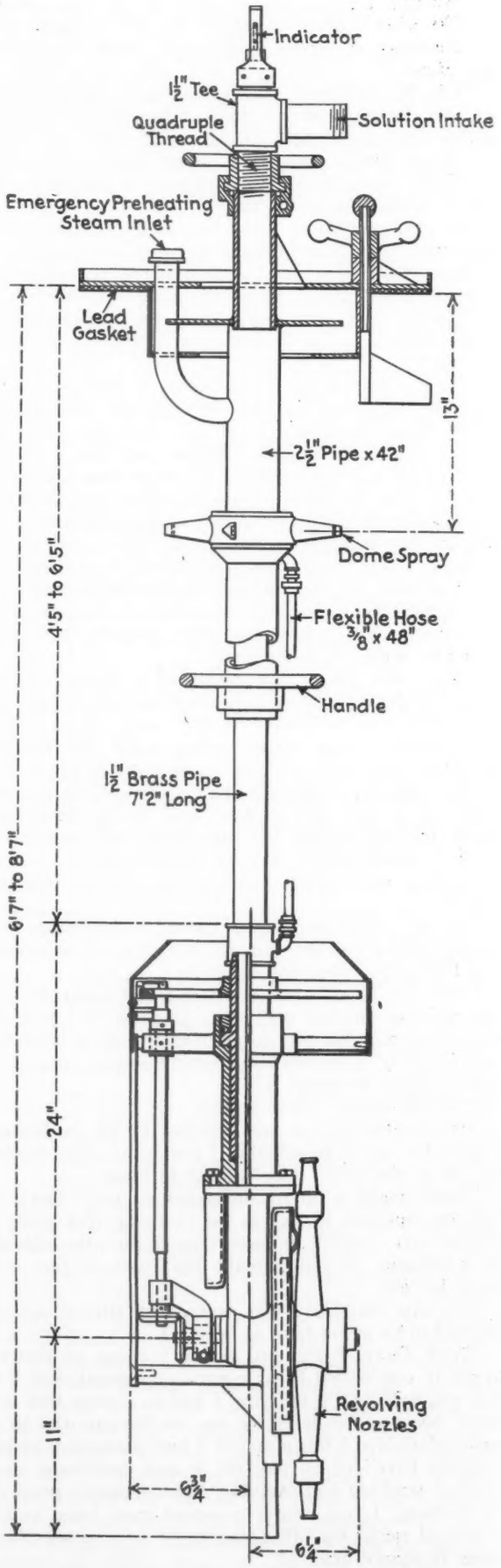
The Pyrate process involves the cleaning of all kinds of tank-car loadings in the edible and inedible oil and grease class, fuel and lubricating oils in the petroleum class; also various kinds of chemical loadings. The mechanical cleaning machine is said to do unusually effective work, enabling changes in car service to be made from one commodity to another without contamination of the lading. Another important advantage is the elimination, in most instances, of the necessity of steaming the cars before cleaning. Labor conditions in the repair yards and cleaning tracks also are improved, since it is easier to clean tank cars, and, owing to the more thorough cleaning of the cars, men using cutting or welding torches on repair work can operate with less discomfort and danger from smoke and gases.

The illustrations show Pyrate tank-car cleaning machines installed on a double-track rack at the East Chicago plant of the General American Tank Car Corporation. While two machines are included in this set-up, it is anticipated that more will be installed at such a time as production demands warrant. These machines are leased by the Pyrate Corporation, which, in turn, supplies the chemicals required in the cleaning operation.

The Pyrate machine is made almost entirely of bronze and brass to eliminate the possibility of ignition by sparking, should the machine accidentally bump against the inside of a car containing inflammable gases. Special attention has been given to wearing parts, stainless steel being used wherever possible. As may be seen from the illustrations, the machine comprises essentially a pipe assembly extending through a false dome cover and provided with a three-inch flexible wire wound hose connection at the top to supply the cleaning chemical under pressure; a standard steam hose connection at the dome cover for use when it is necessary to steam the cars; a series of four stationary nozzles just below the false cover and used in cleaning the dome; and a pair of rotating nozzles at the lower end of the pipe for cleaning the interior of the main tank. These lower nozzles revolve slowly in a vertical plane and also in a horizontal plane under gear drive from a small turbine, thus cleaning effectively all interior parts of the tank.

The machine is supported by a counterweight from a swing crane over the cars, thus permitting its ready application to, or removal from, the tank-car dome. The dome cover is clamped in place by means of wing nuts and adjustable clamps. An adjustment feature permits lowering the revolving nozzles to the proper position near the center line of the tank, regardless of the tank's size. The dome cover also is designed to fit all standard sizes of dome openings. All projecting parts of the machine are well guarded against any damage which might occur in handling.

During the actual cleaning operation, the prepared chemical solution, contained in tanks below the ground, is forced, by means of a steam pump, through pipes into the machine and out of the rotating nozzles in two concentrated streams under 150-lb. pressure. At this pressure and with the nozzle size and design provided, the two streams of a chemical solution can be thrown, in practically a straight line, a distance of over 60 ft. The nozzles revolve in a vertical plane step by step, a degree at a time, and the entire nozzle support and gear drive assembly revolves about a vertical axis at a speed which is automatically varied so that twice as much time is al-



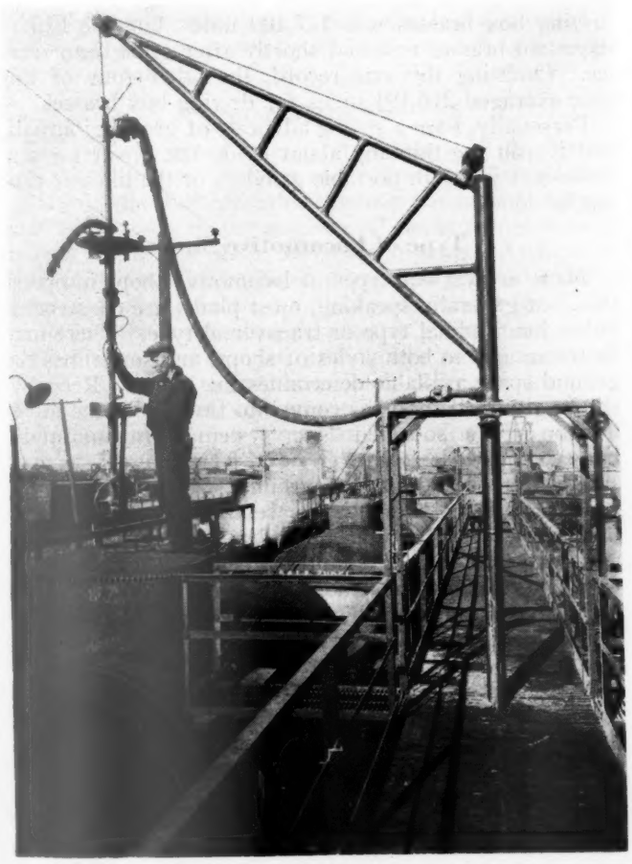
Assembly drawing of the Pyrate tank-car washing machine

lowed for cleaning the ends of the car as is used in cleaning the sides. Two underground storage tanks of 1,000-gal. capacity each are used for the chemicals, one for the cleaning of petroleum service cars and the other for edible and inedible commodity cars.

In practically all 10,000- and 12,000-gal. tank cars, no vertical adjustment of the machine is necessary in the cleaning operation, as the nozzles work at any point desirable between the top and bottom sheets. However, in some 6,000- and 8,000-gal. tanks, which are lower and longer, the angle at which the stream strikes some of the sheets in the car is quite small. To increase this angle of action to a sharper or more direct hit, the machine, while working, is raised and lowered by turning a wheel which revolves on a quadruple thread. Half the cleaning operation can then be performed with the machine near the top of the car and the remaining half with it located near the bottom. This enables the two streams of cleaning solution to strike the tank sheets more directly and effectively.

The machine is said to perform the following duties: Apply heat at a constant temperature; apply a scrubbing force for cleaning with a chemical especially prepared to attack the substance to be cleaned and still allow it to be rinsed free. After the mechanical cleaning operation is completed, the car is cooled by the machine in about 15 min. so that a man can enter the dome to brush out any remaining sludge and water which does not drain out.

The alkaline chemicals furnished by the Pyrate Products Corporation and used in the cleaning operations are the result of several years' experiment with all types of car cleaning. For deodorizing tank cars previously loaded with such products as petroleum, fish oil, etc., this company has developed a new product known as Pyrasol, a stable form of chlorine, which performs the double function of cleaning and deodorizing. Pyrasol, which comes in crystalline form, previous to solution, has also been used for cleaning and deodorizing refrigerator cars.



View of the Pyrate automatic, mechanical, tank-car washing machine as installed at the double-track cleaning rack of the General American Tank Car Corporation at East Chicago

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Joint Evidence for Improper Work

The Union Pacific executed joint evidence cards for alleged improper work and work claimed not performed on a number of Union Pacific cars returned by the Missouri Pacific at Kansas City for items such as coupler yoke rivets improperly applied; defective air brakes; air brake retainer valves not cleaned and improper second-hand brake beams applied, and presented these cards to the Missouri Pacific along with billing repair cars. The joint evidence cards were rejected by the Mo. P. on the grounds that Rules 12 and 13 do not authorize the use of joint evidence to establish liability on the part of the repairing line in the cases in question. The Union Pacific contended that joint evidence was final and that the Mo. P. should furnish defect cards to cover. In the case of the cars involving loose coupler-yoke rivets the Mo. P. stated that the cars left its repair tracks with rivets tight and in first-class condition and contended that it was entirely possible that the rivets might become loose or broken in subsequent yard or road movements. The Mo. P. contended that the air brakes on the cars in question were properly cleaned under the provisions of Rule 60 and, in the case of the retainer valves, it was claimed that it is impossible for anyone to state positively whether or not such valves have been cleaned two or more days after the work has been done, particularly in damp, rainy weather. The Mo. P. refused to recognize the use of joint evidence in all of the cases where it was shown that "brakes would not set in position No. 2 or release in position No. 4," claiming that the brakes on the cars involved were cleaned in accordance with Rule 60.

In a decision, rendered November 4, 1932, the Arbitration Committee said that "Rule 12 does not authorize the use of the joint evidence card for the purpose of determining whether or not work was actually performed or whether serviceable second-hand material was used. A definite statement has been made by the repairing road that the cleaning reported was actually done and that brake beams were not defective at the time of application. Therefore, the contention of the Union Pacific is sustained in only where joint evidence shows that air brakes failed to pass the required tests by the single-car testing device, and were subsequently cleaned within 60 days in accordance with the provisions of Rule 60, Section (i), Paragraph (4) "—*Case No. 1721, Union Pacific vs. Missouri Pacific.*

In the Back Shop and Enginehouse

Locomotive Repair Shops And Modern Locomotives*

By John Roberts†

I feel sure that all mechanical officers will agree that, generally speaking, our present locomotive repair shops are not at all adequate to meet the needs of the power of today. The relation of the locomotive shops to the locomotive itself is too closely allied to be ignored any longer, if the railroad companies are to avail themselves of its maximum efficiency.

When we look around our many shops, one has to admit that the locomotive shop and shop practice have not kept pace with recent locomotive developments. Of course, there are various reasons for this condition—principally, I think most locomotive repair plants were built before the present-day power was developed—consequently, the larger locomotive finds itself in a place altogether too small and not adapted to its needs. Unfortunately, the mechanical department has too often been looked upon as a "spending department," and the mechanical officers find it difficult sometimes to get the necessary capital to keep their equipment up-to-date, with the result that a great many obsolete machine tools are still in operation at a loss to the company.

If we contrast this condition with the automobile industry, what do we find? No sooner does a machine or tool become obsolete than it is replaced with the most efficient tool on the market—a new engine is developed, immediately the entire plant is re-organized.

The railway mechanical officer has himself partly to blame for what is sometimes referred to as inefficiency—he has been too prone to say (perhaps under pressure) "Yes, we can get along for another year!"

I also want to say, even in the face of all we read in our trade journals and railway periodicals, that the machine tool builder is also partly to blame. They have not in the past kept pace with the requirements of the locomotive shops—perhaps because of the limited market for their product. I do not mean this to cover standard tools, such as lathes, milling machines; shapers, etc.—what I have in mind is special requirements to give better production, reduce cost and increase efficiency. For instance, where would you find a high class piece of machinery today with the journal bearings turned and rolled, and yet this is what most locomotive shopmen are doing with the result that the very foundation of the locomotive is inefficiently machined at the start. I know it is an easy matter to grind the journals on the main driving axles before the wheels are applied—this can be done on any good piston rod grinder and is a practice which should be standard—but it is another matter to grind the journals after the wheels have been applied. Some few years ago we made a very careful study of this subject and found it would be a good practice to grind all journals on locomotive driving wheels, as we believed that apart from getting a more highly efficient job, considerable economy was to be effected. Unfortunately, however, there was no machine on the market in the United States or Canada, capable of doing this work. We then got one of our machine tool builders to look into the subject, with the result that a journal truing and grinding machine was developed—the first of which was installed in the new Canadian National shops at Montreal. Perhaps it would be interesting to give you a few figures taken at random as to the mileage made by ground journals and journal brasses.

Recently, we shopped one of our 5700 class Hudson type locomotives, which had made 247,101 miles, and the maximum amount of wear found on any driving journal was .025-in. and the maximum amount out of round was .012-in. These axles were calipered at the hub end, center and inside of the journal. The driving box brasses had lasted the full mileage of 247,101 miles. You will understand, of course, that these were floating bushing type driving boxes. An examination of our records show that from the five locomotives of this type operating on our road in fast passenger schedule between Montreal and Toronto, the average life of the driving box brasses was 177,109 miles, but one had to have two brasses renewed shortly after going into service. Omitting this one record, the other four of this type averaged 216,191 miles for driving box brasses.

Personally, I am a strong advocate of ground journals, and if you are thinking about it, do not go in for any makeshift job with portable grinders or the like—it cannot be done.

Type of Locomotive Shops

There are various types of locomotive shops in operation, but generally speaking, most plants are constructed either longitudinal type or transversal type. There may be advantages to both styles of shops, and sometimes the ground space available determines the layout. Recently, the longitudinal shop has come into favor with the introduction of the so-called "spot system." In our study, however, we decided to go to the transversal type of shop—first because of the ground space available, and secondly because we thought we could develop a shop having the entire equipment under one roof, which has great advantages in a country where we get very cold weather during winter months. We also had in mind laying out a shop which would enable us to route materials from one department into another with the least possible travel.

I would like to tell you an interesting experience which was forced upon us when the railways now constituting the Canadian National were consolidated—and you may find this an interesting study if you go in for it. In this consolidation, we had practically five separate railroads—all furnished with their own rolling stock, their own shops in their respective territories, their own shop equipment and practices in operation. It certainly was a study. However, we decided to develop a set of standard maintenance regulations for the purpose of standardizing shop practices and also locomotives, and

*Abstract of a paper presented before the New England Railroad Club at a meeting held January 9, 1934.

† Chief of motive power and car equipment, Canadian National.

in doing so, we found that the shop methods of all our shops could be greatly improved—and do not forget that this consolidated railroad reaches from the Atlantic to the Pacific ocean, having a total mileage of 24,000 miles of railway, with a diversity of geographical and climatic conditions. However, the maintenance regulations were prepared and from this study, the new Point St. Charles shops[1] were built to embrace the standards which had been adopted.

Unit Measurement System

It was also felt that some standard measuring stick should be adopted for measuring shop production, particularly as some of our plants were working on a straight time basis, others were operating on a bonus system. To eliminate the bonus system was to remove the measuring stick in those shops. To introduce the bonus system in the other shops at that time was not desirable. It was then decided to develop some system which would enable the shop management to know what progress was being made. This was not an easy task. First, we tried to develop a measuring stick based on tractive effort, then on haulage capacity, and also on the potential horsepower basis, but none of these were practicable or sufficiently accurate to be of any value. It is also a well-known fact that the A. R. A. classification of repairs is of no value, because of the varied cost of reconditioning locomotives. Latterly, we adopted a unit measurement system based on the "man-hour"—this system has worked out very well and is sufficiently accurate to give us a close shop efficiency figure month by month for each locomotive and car repair shop.

Considering the large amount of money spent in labor and material per month in a large locomotive shop, it is not fair to the shop superintendent, unless you can give him some measuring stick by which he can tell what progress he is making.

Shop Methods

Let me here again refer to the subject of shop practices. I might say that on our railroad, on account of the size of the railway, which necessarily employ a large number of men in the mechanical department—having quite a number of shops scattered from the Atlantic to the Pacific—we have found it necessary to establish a shop methods department which comes under the jurisdiction of the mechanical department. This department has been a valuable asset, particularly as the men employed in it are trained mechanics who are used for inspection purposes, conversant in the operation of the unit measurement system and also developing shop practices and methods, etc. It would be interesting perhaps to mention that when our maintenance regulations were first developed, a limit of wear was established for the various moving parts, also tolerances of fits covering the locomotive machinery, etc.

Ground Journals—We have found that, as previously stated, the ground journal on the axle was a step in advance of any previous practice, also that a closer and better fit of the axle box, brasses, should be accomplished. We have adopted steel liners on our driving wheels and have found that the best material for this purpose is standard boiler plate. When these liners are applied by the welding process, they practically last the life of the wheel. We then found that to make a good application of brass liners to boxes, it was advisable to use the electric welding process for fastening the brass liners to the boxes. This particularly applies to a floating bush type. This can best be done by changing the polarity of the electric welding generator and using a special electrode for the purpose.

Piston rod work—Another practice which I think would be of interest is the machining and fitting of piston rods to crossheads. We grind all piston rods within .002-in. tolerance, being very careful to see that all radii are properly rounded out without tool marks, and the piston rod is then fitted to the crosshead. Gages and reamers are used for maching the crosshead to a standard taper and fit, making sure that the fit is properly smoothed out without tool marks. The end of the piston rod is also machined to a gage and carefully fitted to the piston and pressed into position. We do not approve of the common practice of drawing the piston rod up with a temporary key, as from our experience, we have found more fractures starting at the piston rod keyway through the use of the temporary key than otherwise. The enginehouses were also notified to eliminate breaking the crosshead fit as much as possible.

Grinding of Motion Links, Blocks, Etc.—I might also mention that an interesting development has been made in the motion gang, where we adopted a link grinder and an internal grinder combined, thus enabling one machine to take care of all the grinding work necessary in the motion gang. This means that we can grind our motion links and link blocks, and swinging the pendulum out when not in use, the grinding head (being a No. 2 internal grinder) takes care of grinding the motion bushes.

Nickel cast iron cylinders—A few years ago, we were almost at the point of going to a cast-steel cylinder, but in recent years, we have developed a locomotive cylinder manufactured from nickel iron (60 per cent steel and 1 per cent nickel) having a tensile strength of 35,000—40,000 lb. per sq. in. This metal has a Brinnell hardness of from 207 to 230, which is easily machined, giving a good smooth finish and a good grain structure in heavy sections.

Electric flue welding—The adoption of electric flue welding has also greatly assisted in getting longer tube mileage. Our practice is to lightly bead the flues at the back end and then electric weld them to the tube sheet—the flue being prossered on the water side of the back tube sheet before the bead is formed. Instructions are also issued that at each washout period, the flues are given a light prossering, which means that they are constantly kept up against the back of the tube sheet, and that by the prossering process the scale is removed from the flue on the inside of the tube sheet.

Firebox application—I feel sure that you will all agree that the welding process has also changed the method of locomotive repairs, particularly the application of new fireboxes, one-half side and three-quarter side sheets. At one time it was necessary to take the boiler out of the frames and send it to the boiler shop for firebox renewal. Now, with the present practice, new fireboxes can be applied in the erecting shop in four or five pieces.

Double-gunning of staybolts—A very interesting development which has greatly reduced the possibility of staybolt leakage is that of double-gunning staybolts. This is a process in which we use Chicago Pneumatic No. 11 pneumatic hammers supported by a pneumatic "holder-on"—both guns working on the inside and outside of the staybolts at the same time with an especially developed tool manufactured to expand the staybolt from the inside, thus tightening up on the thread on the firebox sheet. Of course, it must be understood that we are using exclusively hollow staybolt steel for this purpose. A leaky staybolt on our railroad is a thing of the past. We find that by the double-gunning process, we save on an average about 25 per cent over the old method of

[1] (These shops were described in detail in the March, 1930 issue of the *Railway Mechanical Engineer*—EDITOR.)

staybolt application. A fair average performance on a straight away job on a side sheet is 50 to 55 staybolts per hour. At the same time this process removes the fatigue of the boilermaker, which makes it a preferable job from his point of view.

Heat treated tires—We are using heat treated tires. This necessarily caused us to develop a furnace with temperature control. Our Maintenance Regulations call for a maximum of 600 deg. F. for the application of tires, and prohibits any part of the tire being heated beyond 800 deg. F. It is necessary that this regulation be rigidly enforced in order that the temper of the heat treated tires which we use shall not be destroyed in the process of application. The electric tire heating furnace has an automatic pyrometer control, the power cutting out at 700 deg. F. and cutting in again when the temperature of the furnace drops to 650 deg. F. The capacity of the furnace is four tires per charge, and the tires remain in the furnace for about 90 min. The power is on for only about one-half this period, however, as the control cuts in and out as the temperature of the furnace rises and falls to the high and low limits. The load is approximately 90 kw. and, figuring on 1 cent per kilowatthour for power, the cost of heating would be 17 cents per tire.

Quartering machine—We have a special quartering machine which was developed by one of the machine tool companies. The first machine built was installed at Point St. Charles shops, Montreal. With the introduction of this machine, we find that it is possible to quarter our crankpins accurately within .002-in. for a 14-in. throw and the alignment is perfect. Since the introduction of this machine, we find it preferable, particularly on large power, to rough machine the crankpins to within a reasonable limit and finish them in the quartering machine, which gives us much more accurate work than finishing the crankpins and pressing them into place.

Locomotive spring repairs—I would also like to make mention of the subject of spring repairs. For a great many years, the practice in our locomotive shops for repairing springs has been simply governed by the "rule of thumb method." I also intend to show you a picture of our latest spring plant. All springs from locomotives undergoing repairs are sent to the spring shop for examination. If springs have no visible defects, they are put in the testing machine, and, provided they assume the correct height under load, they are lubricated by being immersed in a bath of leaf spring lubricant which is maintained at a temperature of 180 deg. F. After being immersed for 45 minutes, they are drained and sent back to the erecting shop.

For springs requiring repairs or new springs being made, the process is as follows:—The leaves are heated to a temperature not exceeding the hardening temperature and formed on the forming machine. After forming, the leaves are re-heated in the furnace to the correct temperature for quenching, quenched and then transferred to the drawback furnace. Electric furnaces are used for the entire process, with automatic pyrometer control. The leaves are inserted on edge, a complete set at a time and are separated from each other while the heating is being done. The hardening temperature is 1550 deg. F. for Carbon or Nickel Molybdenum steel—and 1650 deg. F. for Silico-Manganese or Chrome-Vanadium steel. The drawback temperature is 725 deg. F. for Carbon steel—830 to 900 deg. F. for Silico-Manganese—800 deg. F. for Chrome-Vanadium, and 850 deg. F. for Nickel-Molybdenum steel.

A Brinnell test is made right in the spring shop on a specimen plate from every heat, as a final check on the tempering of each spring. This only takes a minute or so and results in a wonderful uniformity of product. The Brinnell hardness required for ordinary carbon spring steel is 388, for silico-manganese or chrome-vanadium 388 to 418, and for nickel-molybdenum 418 to 430.

The spring buckles are die-forged from bar stock, the bar being lapped at the bottom of the buckle and upset at welding heat in a four-inch forging machine. The cost of these buckles is only about one-third of manually forged buckles and they are by far the most satisfactory buckles we have ever used.

The springs are assembled and banded in a press in the regular way and the buckles stamped. The springs are then tested for load and working height, and, after being lubricated as mentioned before, they are ready for delivery. It should be noted that about 25 per cent of the springs coming into the shop do not require any repairs, and not more than one-third show any broken plates. It is important when new leaves are being cut from a bar to turn the bar over at each cut in order to get the ragged edge on top at each end of the leaf.

Shop facilities for auxiliary equipments—With the introduction of various auxiliary equipments to locomotives, such as boosters, feedwater heaters, superheaters, exhaust steam injectors, stokers, etc., it has become necessary that these equipments should be assigned to a definite department of the shop for reconditioning, just as we assign our air brake equipment.

To my mind, the railway locomotive shops have been subjected to a good deal of undue criticism. Personally, I have often marveled at the splendid performance made in most of our large shops, considering the great disadvantage under which they are called upon to operate. I believe it is much simpler to build up an efficient organization in a manufacturing plant than in a railroad repair shop, particularly when one considers the diversity of operations that are necessary in reconditioning a locomotive—the many problems which the shop forces are faced with, on account of the condition of the locomotives when they arrive at the shops for repairs, also the many complications that enter into the problems on account of the location or the condition under which the locomotives have been operating. Some locomotives come from a bad water district, and you would naturally expect more boiler work than on locomotives coming from a good water district—the curvatures of the railroad, grade conditions, and many other conditions that enter into the wear and tear of the machine confront the shop staff with problems which are not common to any other industry within my knowledge.

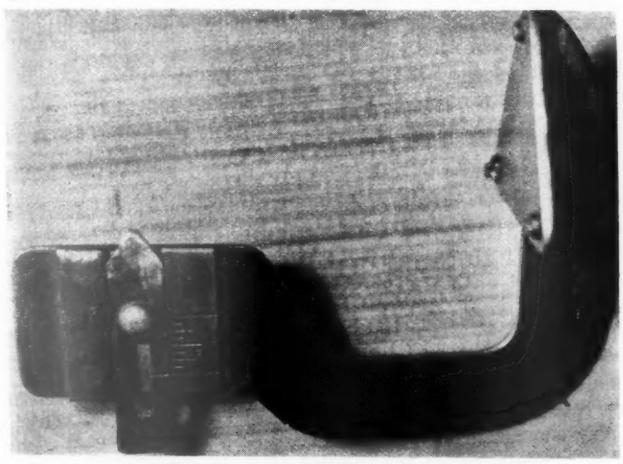
I believe that all railway mechanical officers should give most serious consideration to working to closer refinements in order to develop the best possible class of work known to us, so as to eliminate as much as possible unnecessary repairs at enginehouses.

Much can be done to improve the class of work which shops are called upon to perform. At the same time, let me say that we should also give serious consideration to the many rules and regulations under which we are compelled to operate. It seems to me that some of these rules and regulations which are enforced upon the railway companies were quite right and proper when they were developed, but are now obsolete. Take for instance the developments in locomotive boiler maintenance. The high grade of material used and the class of work performed by the railroads make it possible for us to get from 200,000 to 300,000 miles between retubing. Why locomotives should be taken out of service at the end of five years for external examination, when it is a known fact that the boilers are in good condition, is something that I cannot understand.

Tread Wear Gage For Locomotive Tires

THE tread-wear gage illustrated is for the purpose of quickly and accurately measuring the wear at the tread on locomotive tires and wrought-steel wheels.

The gage is made throughout of ⅛-in. sheet steel, cut and filed to shape. The triangular shaped piece was drilled for three ⅛-in. pins which were filed to ⅛ in. high, then the piece was welded to the body of the gage. The purpose of the three pins is to act as a three-point

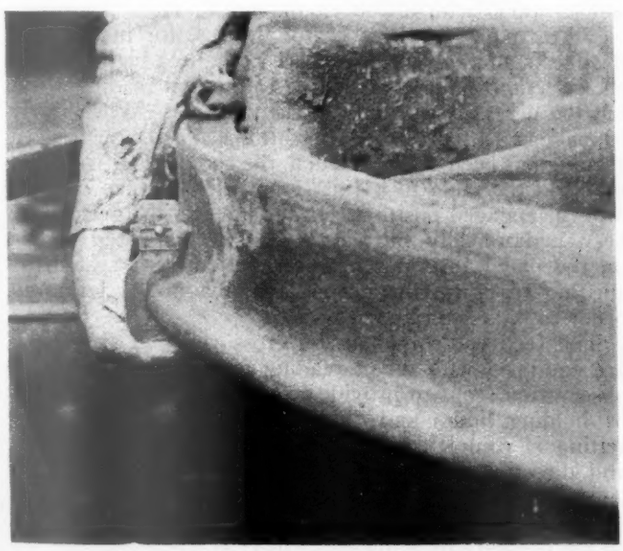


Close-up of the tread gage showing the construction

support for the gage on the inside face of the tire while measuring the height from the top of the flange to the tread.

The guides for the movable points were located to hold the pointer 2⅞ in. from the back of the tire, which is the distance between the pointer and the three pins.

The pointer is slotted and held in position by a loose rivet with a light flat spring washer on the back of the gage. The graduations on the movable pointer are located by moving the pointer down $1\frac{1}{16}$ in. from the bot-



Tread gage being used on a tire

tom edge of the gage frame. This will be the first mark or zero which measures a tread of no wear or a flange of 1⅛ in. standard height. The guide is then graduated in sixteenths to show a wear of $\frac{1}{32}$ in. or more.

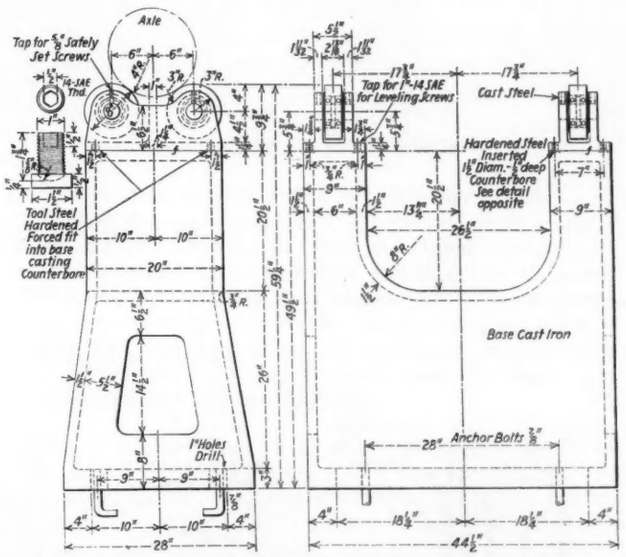
One of the photographs shows the finished gage with pointer set for no tread wear of a flange of 1⅛ in. high. The other shows the gage in position on a tire for checking the tread wear. The wear should be checked at several different points on the same tire, usually the most wear is found at a point just in front or behind the crank pin and at each end of the counterbalance.

Driving-Wheel Counterbalancing

COUNTERBALANCING locomotive driving wheels without accurate and reliable devices for determining the figured weights are productive of doubtful and sometimes discouraging results.

At this time unusual interest is being displayed by members of the A. R. A. in both plain and cross-counterbalancing of locomotives for the elimination of axle and pin failures, together with the attendant effect on high-speed riding comfort, safety and speed.

The drawings shown here explain and describe a device for balancing driving wheels precisely and accur-



A rigid cast iron base anchored in concrete assures accurate balancing

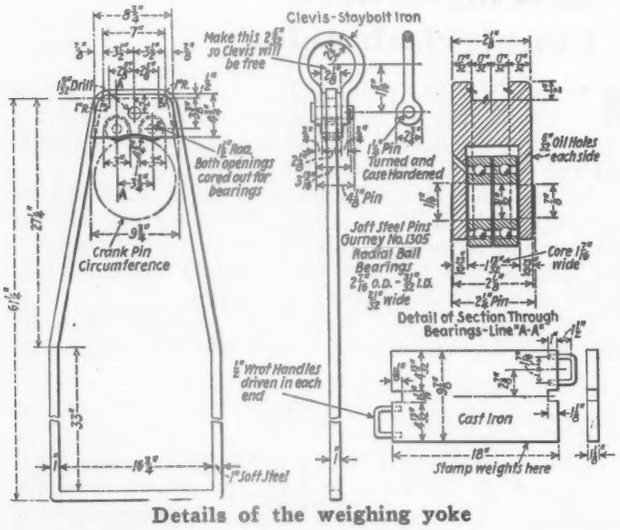
ately. The main portion consists of a cast-iron supporting base with a generous gap in the center to accommodate the center crank of a three-cylinder main wheel and axle assembly. The limits will fit axles ranging from 8 in. to 14 in. in diameter. The height is just enough to clear the yoke nicely from the floor when loaded for a heavy pair of main wheels. The base has a heavy section throughout and is not easily disturbed should the crane operator allow a pair of wheels to drop too hard. In addition, it is anchored to a suitable concrete foundation.

Cast-steel supports for the rollers are mounted on each end of the stand and each is provided with four S. A. E. adjusting screws which adjust against hardened-steel inserts in the top of the base, making alinement simple from the four corners and preventing the roller supports from shifting either way.

The rollers are made of plain carbon steel with case-hardened faces, which are polished to a glass-like finish. Each roller is supported by a 2¼-in. shaft and two annular ball bearings, also provided with retaining casing,

sealing them for the retention of oil and exclusion of foreign matter.

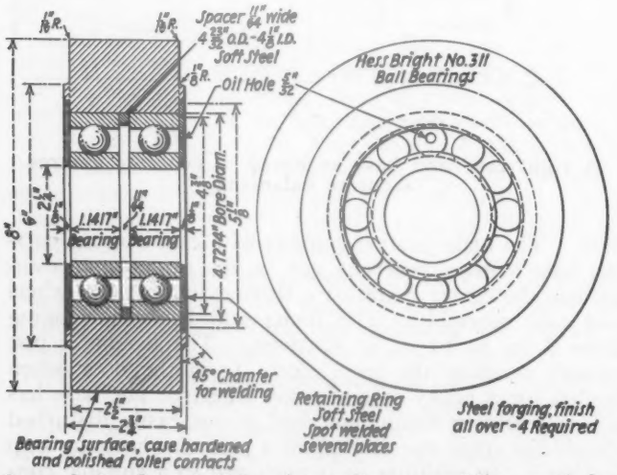
The weighing yoke is fitted with a ball-bearing housing for the pin bearings. This housing is of cast steel, cored out for the insertion of the quadruple, plain radial ball bearings. A wide bearing is desirable here on account of the step in pin diameters at the main for side and main-rod fits. The top portion of the bearing housing is grooved out to take the weighing yoke which is made in one piece. There is also centered here a


Clevis-Staybolt Iron
Make this 2⅝" so Clevis will be free
1½" Drill
1½" Pin Turned and Case Hardened
⅝" Oil Holes each side
1½" Ream, Both openings cored out for bearings
⅛" Pin
Soft Steel Pins Gurney No.1305 Radial Ball Bearings 2⅛" O.D. - ⅝" I.D. ⅝" wide
Crank Pin Circumference
Core 1⅞" wide
Detail of Section Through Bearings-Line "A-A"
1" Wrot Handles driven in each end
Cast Iron
Stamp weights here
1" Soft Steel

Details of the weighing yoke

large ringed clevice for a crane-hook connection to facilitate transferring the weights to opposite pins.

Cast-iron weights are made up in units of 50 lb. each. About 40 of these are provided, each stamped on the outside edge so the weight can be computed when they are piled up in the yoke. Smaller weights are also provided, several weighing 25, 10, 5 and 1 lb., the latter being made of sheet steel of varying thicknesses. Al-


Spacer 1/64" wide
Soft Steel
Oil Hole
Hess Bright No.311 Ball Bearings
1.1417" Bearing
1.1417" Bearing
4.1274" Bore Diam.
45° Chamfer for welding
Retaining Ring Soft Steel Spot welded several places
Steel forging, finish all over - 4 Required
Bearing surface, case hardened and polished roller contacts

One of the four ball-bearing roller assemblies used for supporting the driving axle

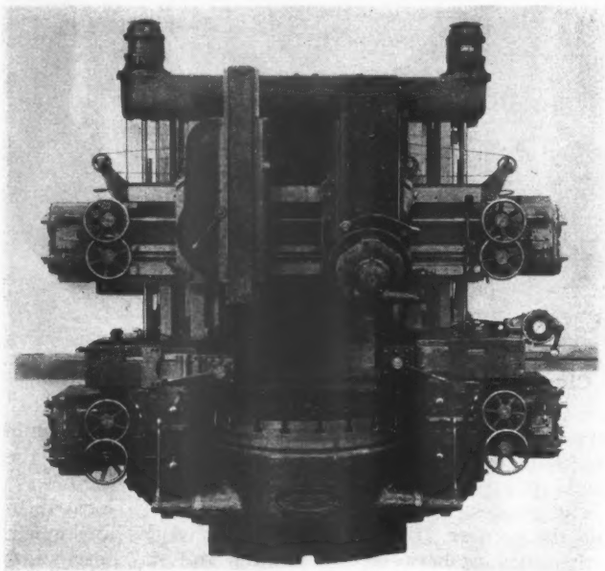
lowance in the total is also made for the total weight of the yoke assembly, which in this case is 283 lb.

The rollers are a decided advantage in design over the straight-edge ways in that the wheels stay in one place all the time. They will not injure the journals and they make the weighing more sensitive. The wheels when so mounted are very susceptible to small changes in weight and consequently better static balance is obtained.

Hydro-Shift Vertical Turret Lathe

THE development of the Hydro-Shift vertical turret lathe by the Bullard Company, Bridgeport, Conn., has made available a machine in which ease of control is combined with complete flexibility to make possible maximum output with the least effort on the part of the operator. This type of machine has been placed on the market in 56 in., 66 in., 76 in. and 86 in. sizes.

The controls are so arranged that the operator has full control of the machine from either side. Any one of sixteen speed changes may be selected by the movement of a crank lever which actuates a direct reading dial. The table speeds of the 56-in. machine, for ex-



The Bullard vertical turret lathe in which speed changes are made hydraulically

ample, vary, with a 900 r.p.m. motor, from 3.1 r.p.m. to 74.1 r.p.m. If the operator desires, for instance, to change from a table speed of 3.1 r.p.m. to a higher speed, the selection is made according to the dial reading without the necessity of stopping the machine. When ready to make the actual change of table speed after the desired reading has been set on the dial, the clutch lever is moved to bring the table to a full stop and then thrown back into the engaged position. In the interval the gears have been hydraulically shifted to the selected speed shown on the dial. It is not necessary under this system of shifting to figure the proper combination of levers in order to obtain the desired speed.

The feed controls, both on cross rail and side head, are equipped with direct reading micrometer dials with observation stops to provide a quick and accurate means of holding limits and duplicating sizes after the first setting is completed. Feed levers control the starting and direction of the feeds, while easily accessible trip levers on the front of the feed works provide a means of stopping instantly the feed of any desired head merely by the pressure of a finger. Power traverse handles are so designed as to spring into neutral immediately when the hand pressure is released, thereby avoiding the danger of being left in traverse and over-running the limit. A further safety device, known as an automatic overload kick-out, covers emergency cases of feed, preventing serious damage from jamming due to careless-

ness or overload. The feed works operate the power traverse at a rate of 13.75 ft. per min. Selector dials with knob controls located on the end of each feed works give a range of 16 feeds on all machines. Hammer hand wheels located on the front of the feed works and accessible from the working position enable the operator to move any of the heads or slides quickly over short distances. In addition this type of wheel permits accurate and fine feeding when starting or finishing cuts.

All of the heads of the Bullard Hydro-Shift are accurately counterbalanced through a system of steel cables and pulleys running on anti-friction bearings. By traveling the weights twice the distance of the sliding members it has been possible to reduce the weights to one half the amount usually required in counter-weighting systems. The counter-weights on this machine are so designed that very little manual effort on the part of the operator is required to move the heads. All of the counter-weights are covered or concealed within the machine, making not only for a neat appearance, but for safety as well.

The bed of the machine is formed by a heavily ribbed casting designed for extreme rigidity and to provide a firm support for the cross-rail, main head and side heads. The sliding members, such as the cross-rail, main head saddles, swivels and side heads, are single unit iron castings, proportionately heavy and properly ribbed to obtain maximum strength, long life with maintained accuracy and the elimination of weaving under heavy cutting. The cross-rail, which is provided with raising screws driven by an individual motor for raising and lowering, will accommodate two heads. The machine illustrated is a 56-in. size with left-hand ram type head for boring and right-hand turret type head. However, the machine may be optionally equipped with two ram type heads. The turret on the turret head is indexed by means of a crank handle driving through a worm gear, precluding the possibility of kick-back on the crank when heavy bars or tools for overbalance the tool weight at other stations of the turret while indexing. Each of the slides may be swiveled right or left at any angle up to 30 deg. Two main heads on the cross-rail are provided with feed works which permit rapid traverse, vertically or horizontally, each independently of the other.

Specifications of Hydro-Shift Vertical Turret Lathes

Capacity	56 in.	66 in.	76 in.	86 in.
Diameter	56 in.	66 in.	76 in.	88 in.
Under rail	47 in.	56¼ in.	62½ in.	68¼ in.
Under turret face	58¼ in.	67½ in.	73¾ in.	79½ in.
Table diameter	50 in.	61 in.	71 in.	83 in.
Turret rail head:				
Vertical movement	30 in.	30 in.	30 in.	30 in.
Will face	56 in.	66 in.	76 in.	88 in.
Left-hand ram head:				
Vertical movement	48 in.	48 in.	48 in.	48 in.
Will face	56 in.	66 in.	76 in.	88 in.
Feed changes:				
Number	16	16	16	16
Maximum	.500 in.	.500 in.	.500 in.	.500 in.
Minimum	.010 in.	.010 in.	.010 in.	.010 in.
Table speeds:				
Number	16	16	16	16
With 900 r.p.m motor:				
Minimum	3.1	2.6	2.2	1.9
Maximum	74.1	60.8	52.4	44.2
With 1,200 r.p.m. motor:				
Minimum	4.2	3.4	2.9	2.5
Maximum	99.5	80.7	69.5	58.8
With 1,200 r.p.m. motor and 17-tooth table pinion:				
Minimum	5.1	4.1	3.5	3.0
Maximum	120.0	98.0	85.0	71.5
Side heads:				
Vertical travel	35½ in.	44¾ in.	51 in.	56¾ in.
Horizontal travel	30⅜ in.	30⅜ in.	30⅜ in.	30⅜ in.
Max. diam. side head will turn	56 in.	66 in.	76 in.	88 in
Min. diam. side head will turn	0	5¾ in.	15¼ in.	29 in.
Floor space:				
Projected	170 in. by 180 in.	180 in. by 192 in.	190 in. by 208 in.	200 in. by 216 in.
Maximum height	173 in.	183 in.	189 in.	196 in.
Weight, two main heads and two side heads	52,000 lb.	61,000 lb.	68,000 lb.	77,000 lb.
Motors (same for all sizes):				
Main	40 hp., 900 r.p.m.			
Rail-raising motor	3 hp., 1,800 r.p.m.			
Power traverse motor	2 hp., 1,200 r.p.m.			

The lubrication system in the Hydro-Shift has been designed with a view to long machine life. The oil pump is located within the bed and connected directly to the head stock. It takes oil from the sump, passes it through the filter system and distributes it under pressure regulated to suit the various requirements. The ways of the rail, saddles and slides are thoroughly lubricated as are the feed screws, racks, pinnions and down feed rods. Forced lubrication is delivered to the spindle bearing and all other bearings, anti-friction or otherwise, throughout the head stock and side heads. The feed works contain their own reservoirs and are not connected to the main system. The filters in the lubrication system are so located near the bottom at the rear of the machine that it is not necessary to remove the rear machine cover in order to clean the filters. In the particular type of filter used it is only necessary to rotate the handle of the filters in order to clean the sludge from the filter and drop it into a sludge sump which is isolated from circulation. A pressure gage just above the speed control dial shows the oil pressure on the machine at all times and through this means indicates when it is desirable to clean the filters.

All of the functions of the main drive rapid traverse and rail raising are accomplished by means of push button control individual motors. Safety limit switches afford a means of protection to cross-rail alinement and mechanism. Both upward and downward movements of the cross-rail are protected by limit switches.

Where cutting-coolant systems are needed the 56-in. Hydro-Shift is provided with a separate water pan and pump, while for the larger sizes the pan is built into the concrete floor in order to give the most suitable foundation necessary for large machines and heavy cuts.

Stationary Cutting Machine

THE Linde Air Products Company, New York, has recently introduced a new stationary cutting machine known as the Pantosec, which is especially designed for cutting dies, cams and other parts that must be smoothly and accurately cut. This machine has a cutting range of 44 in. longitudinally, and 20 in. laterally, and it permits of straight-line cutting, angle cutting, beveling, circular cutting and intricate shape cutting. The floor space required by the machine is 72 in. by 83 in. The Pantosec may be operated from either the template end or the blowpipe end, as a hand-guided or machine-guided instrument. Angles may be cut without templates since the cutting head can be locked for travel in either direction. Bevel cutting is simplified through the provision for adjusting the machine to the work so as to make it possible to line up the blowpipe without shifting the work, and the dividing head enables the operator to set stops on work that is to be cut in several directions.

An extension so mounted as to be steady and secure makes it unnecessary for the operator to return to the back of the machine to start the profile cutting after the entry cut has been made.

The machine consists of a carriage mounted on three-point supports. The piping for the gases is all enclosed in the carriage and all drives are protected by dirt-proof casings. A motor for either 110- or 220-volt current may be specified. The wiring is concealed and switches and controls are labeled and easily accessible.

Among the Clubs and Associations

TORONTO RAILWAY CLUB.—Steel Processing was the subject discussed by F. A. Sherman, vice-president, Dominion Foundries & Steel, Ltd., before the meeting of the Toronto Railway Club on February 2.

NORTHWEST CAR MEN'S ASSOCIATION.—At the meeting of the Northwest Car Men's Association on February 5 proposed changes in the A. R. A. rules and the new loading rules were discussed.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—L. K. Sillcox, vice-president, New York Air Brake Company, presented a paper on the AB air brake at the February 5 meeting of the Indianapolis Car Inspection Association.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Changes in A. R. A. Loading Rules was the subject for discussion by C. J. Nelson, superintendent, the Chicago Car Interchange, before the meeting of the Car Foremen's Association of Chicago on February 12.

PURCHASES AND STORES DIVISION.—A contest for the best paper relating to railway purchasing and stores work has been announced by the Purchases and Stores Division, American Railway Association. As in contests held in previous years, all employees below the rank of assistant purchasing agent and assistant general storekeeper are eligible. ¶ Three members of the general committee of the division have been appointed to judge the papers, as follows: J. C. Kirk, assistant general storekeeper, Chicago, Rock Island & Pacific; G. H. Walder, purchasing agent, Chicago, Milwaukee, St. Paul & Pacific; and L. B. Wood, general storekeeper and assistant purchasing agent, Southern Pacific lines in Texas and Louisiana. Each paper must contain 1,000 to 3,000 words and must be submitted to W. J. Farrell, secretary, Division VI, Purchases and Stores Division, American Railway Association, 30 Vesey street, New York City, not later than April 1.

FOURTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS.—In accordance with the resolution adopted at Stockholm in 1930 the Fourth International Congress for Applied Mechanics will be held in Cambridge, England, July 3 to 9. An English organizing committee has been formed and the Applied Mechanics Division of the American Society of Mechanical Engineers is co-operating with the committee with the idea of co-ordinating the participation of other American groups in this congress. The subjects to be discussed will be grouped under four general headings: Rational Mechanics, including vibrations of structures and machines; Mechanics of Fluids, including turbulence, the boundary layer, heat transfer and compressible fluids; Materials, including elasticity, plasticity, fatigue and crystal structure, and Water Waves, including resistance and stability of ships and seaplanes. Inquiries regarding the Congress and promises of manuscripts should be addressed to the Applied Mechanics Division of the A. S. M. E., 29 West Thirty-Ninth street, New York. Summaries of about 300 words in length, written in English, German, French or Italian, will be required about April 1.

RAILWAY CLUB OF PITTSBURGH.—At a meeting of this club held at the Fort Pitt Hotel on January 25 John Dickson, engineer, Westinghouse Electric & Manufacturing Company presented a paper in which the possibilities of the Diesel engine in railroad service were discussed. Mr. Dickson told the story of the development of the Westinghouse Diesel engines which are now being built in several cylinder and horsepower combinations and described the design and construction of the engines. In concluding his paper the speaker emphasized the point that the advocates of Diesel engines for railroad service do not offer them as a facility for completely replacing steam locomotives but suggest the economic possibilities of this type for certain definite classes of service.

Directory

The following list gives names of Secretaries, dates of next regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 2205, 150 Broadway, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

AMERICAN RAILWAY ASSOCIATION.—Division V.—MECHANICAL.—V. R. Hawthorn, 59 East Van Buren street, Chicago.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorn, Chicago.

DIVISION VI.—PURCHASE AND STORES.—W. J. Farrell, 30 Vesey street, New York.

DIVISION I.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Columet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, Room 332, 30 Church street, New York.

MACHINE SHOP PRACTICE DIVISION.—R. E. W. Harrison, 6373 Beechmont avenue, Mt. Washington, Cincinnati, Ohio.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—Edgar J. Kates, 1350 Broadway, New York.

FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month except June, July and August, La Salle Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth street, Council Bluffs, Iowa. Regular meetings, second Tuesday of each month at Council Bluffs.

CENTRAL RAILWAY CLUB OF BUFFALO.—M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month except June, July and August, at Hotel Statler, Buffalo.

CLEVELAND RAILWAY CLUB.—F. B. Frericks, 14416 Alder avenue, Cleveland, Ohio. Meeting second Monday each month, except June, July and August, at the Auditorium Hotel, East Sixth and St. Clair avenue, Cleveland.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m. Noon-day luncheon, 12:15 p. m. for Executive Committee and men interested in the car department.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILERMAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, R. F. D. 5, Peoria, Ill.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md. Annual meeting October 17-18, Hotel Stevens, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver buiding, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION.—E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division American Railway Association.

TORONTO RAILWAY CLUB.—N. A. Walford, district supervisor car service, Canadian National, Toronto, Ont. Meetings first Friday of each month except June, July and August.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

WESTERN RAILWAY CLUB.—C. L. Emerson, 822 Straus Building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

NEWS

THE LOUISVILLE & NASHVILLE, on January 16, recalled 800 men to work at its shops at Louisville, Ky.

THE CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC is inquiring for 25 baggage cars.

THE LOUISIANA & ARKANSAS is inquiring for three 2-8-2 type locomotives.

THE ALASKA RAILROAD is inquiring for 20 50-ton hopper-bottom coal cars.

THE DOW CHEMICAL COMPANY has ordered two aluminum tank cars of 8,000 gal. capacity from the General American Transportation Corporation.

THE CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC has awarded a contract to the Thorgersen & Ericksen Company, Chicago, for the construction of a blacksmith shop at Milwaukee, Wis., a portion of which was destroyed by fire on January 8. This is a one-story structure, 80 ft. by 416 ft., and is of concrete and steel construction. The reconstruction work will involve an expenditure of $46,000.

Progress on P.W.A. Loans

THE $3,300,000,000 fund appropriated for the P. W. A. has now been practically all allotted but more is expected at the hands of Congress and some considerable sums may yet be available from allotments which are not taken up. On January 25 it was announced that the first check had been mailed out by the Public Works Administration to the Pennsylvania for $6,990,000, as the first installment on the loan of $77,000,000 for electrification work and the acquisition of 7,000 freight cars and 101 electric locomotives. The money will be expended in the next 60 days. Many railroads that have been negotiating with the P. W. A. for loans have been delayed in the completion of their plans because of the difficulty in obtaining definite price quotation pending the adoption of the manufacturers' codes. However, it is expected that the codes for the locomotive and car manufacturers will be approved at an early date. The following allotments have been made in addition to those announced in the January issue:

Lehigh Valley.—The P. W. A. has allotted an additional $500,000 to this road for the purchase of five new locomotives.

Midland Continental.—This company has been allotted $40,000 by the P. W. A. for the purchase of one Diesel locomotive to cost approximately $52,000. The report of the Midland Continental to the commission states that the company operated such a locomotive experimentally for four months in 1932 and showed a saving of 0.66030552 mill a gross ton-mile as compared with the cost of operating a steam locomotive.

The New York, New Haven & Hartford has been allotted $2,000,000 additional by the P. W. A. for the purchase of 50 passenger cars. The company is now asking for bids for this equipment and for a streamlined train.

Further progress is noted in the preliminary inquiry sent out by the Central of Georgia and the orders of the Chesapeake & Ohio, the Erie and the New York, Chicago & St. Louis:

Freight cars	Passenger cars	Locomotives	Order placed with
	CENTRAL OF GEORGIA		
200 70-ton hoppers			
	CHESAPEAKE & OHIO*		
500 hoppers			Canton
850 hoppers			A. C. F.
1,000 gondolas			A. C. F.
50 automobile (with loading devices)			A. C. F.
1,150 hoppers			Standard Steel
650 steel box			P. C. & M.
750 hoppers			Ralston
100 furniture			Mt. Verron
500 hoppers			Pressed Steel
2,250 hoppers			General American
	15 steel coaches		St. Louis Car
	11 steel mail and express		St. Louis Car
	ERIE		
500 50-ton automobile			A. C. F.
500 50-ton box†			A. C. F.
750 50-ton hoppers			Standard Steel
750 50-ton hoppers			Pressed Steel
750 50-ton hoppers			Greenville
250 70-ton hoppers			Ryan
125 70-ton flat			Ryan
100 40-ton furniture			Magor
	50 semi-suburban		A. C. F.
	50 suburban		P. C. & M.
	25 suburban		Pressed Steel
	NEW YORK, CHICAGO & ST. LOUIS*		
675 gondolas			Bethlehem
25 flat			Ryan
500 box			P. C. & M.
	5 coaches		P. C. & M.
	2 air-conditioned coaches		P. C. & M.
	1 steel mail and express		St. Louis Car
		15 2-8-4	American
		5 0-8-0	Lima
		20 tenders, 1,900 gal. cap.	Lima

* All of the freight cars for the C. & O. and N. Y. C. & St. L. are of 50 tons' capacity.
† 350 with loading devices.

The 500 freight cars to be purchased by the Lehigh & New England have been classified as follows: 250 steel box cars, 150 all-steel hopper cars, and 100 composite flat gondola sars.

The program of the Boston & Maine involves repairs to 25 locomotives, general repairs to 818 freight cars and 80 passenger cars, air-conditioning of 10 cars and new seats for 10 cars.

The 7,000 cars to be built by the Pennsylvania will consist of 500 steel box cars 40 ft. 6 in. long, 10 ft. high, and 9 ft. 2 in. wide, designed for carrying automobiles and equipped with mechanical loading devices enabling each car to haul four automobiles instead of two or three; 3,000 of this type of car without the automobile loader; 2,000 standard steel box cars and 1,500 flat cars 50 ft. long of 70 tons capacity.

Of the 7,000 cars, 166 box cars with loaders, 1,000 box cars without loaders, 668 standard steel box cars and 500 flat cars, a total of 2,334, will be built at the P. R. R. Altoona (Pa.), shops; 167 steel box cars with loaders, 1,000 box cars without loaders, 666 standard box cars and 500 flat cars, a total of 2,333 cars, will be built at its Enola shops, and the same number and types of cars will be built at its Pitcairn shops. This will provide a year's employment at Altoona for about 400 men, who will be required for work on the fabrication of material for all the cars and about 300 men who will be engaged in construction work. In addition 300 men employed on construction work will be given a year's employment at each of the other two shops.

Later in the year 101 electric locomotives —59 for freight service, 28 for passenger service and 14 switchers—will be acquired.

Splawn Appointment to I. C. C. Confirmed

THE PRESIDENT'S appointment of Dr. W. M. W. Splawn as a member of the Interstate Commerce Commission, succeeding Ezra Brainerd, Jr., was confirmed by the Senate on January 27, following a favorable report by the committee on interstate commerce on January 16 when opposition of the railroad labor organizations to the appointment of Dr. Splawn as a member of the Interstate Commerce Commission was withdrawn.

I. C. C. Inspectors Check Condition of Equipment

THE RESULTS of a detailed inspection of freight cars and locomotives, recently completed by the Bureau of Safety and Locomotive Inspection of the Interstate Commerce Commission, at the request of the Federal Co-ordinator of Transportation, were made public on January 4, as briefly reported in the January issue of the *Railway Mechanical Engineer*.

Late in the summer inquiries were directed to the Co-ordinator from various sources respecting the adequacy of freight equipment to protect possible increase in traffic during the fall months. It was generally recognized that considerable maintenance had been deferred and some doubt was expressed as to the ability of the railroads to meet the prospective demands. Freight car and locomotive statistics, maintained by the American Railway Association, and released currently through the Car Service Division, reflected an apparently satisfactory condition, but in view of the doubts expressed as to the entire accuracy of these reports, a special check was arranged for, Mr. Eastman explained.

The check covered a large portion of the cars reported as stored in serviceable condition, and most of the locomotives. It consisted of actual examination of the equipment by inspectors of the Interstate Commerce Commission.

"The facts developed by this examination lead to the conclusion that neither the fears of a freight-car shortage nor the optimism of those who relied upon railroad reports of surplus equipment were fully justified," according to Mr. Eastman's statement. "Had the anticipated increase in fall business been realized, it is probable that the supply of serviceable cars would have been fully absorbed, although the surplus was apparently sufficient, at least numerically, to have averted a serious shortage."

The railroads whose cars were examined reported as of October 1, 118,854 stored cars fit for the transportation of all commodities for which designed. The inspection developed that 55.5 per cent of these cars were fit for the service for which they were designed, and 4.4 per cent were found unfit for any service until given repairs estimated to cost $350 per car. The balance, comprising 40.1 per cent of the stored cars, were suitable for the transportation of certain commodities only. A further analysis of the reports shows that 56 per cent of the cars inspected were constructed prior to the year 1920. The cars covered by this survey did not include cars definitely classed as "Bad Order."

The check of locomotive condition was somewhat less assuring than that of freight cars. The railroads reported 5,549 locomotives stored in serviceable condition. Of these, 4,162 were inspected. Of those inspected, 3,275, or 78.7 per cent, were actually ready for service, while 887, or 21.3 per cent, were in need of repairs requiring three days or more time and the expenditure of $150 or more.

The locomotives were further classified as to type, age and tractive power. It was found that a substantial number of the stored locomotives were of types designed for switching and passenger service, and those whose wheel arrangement and tractive power would indicate their use for branch line and secondary service. Locomotives built prior to 1910 constitute 41.9 per cent of the stored power inspected, while an additional 39 per cent range from 13 to 23 years of age, leaving but 19.1 per cent less than 13 years old.

From the standpoint of tractive power, the adequacy of the locomotive reserve is still further out of proportion to the numerical ratio of stored locomotives to total owned. Of the units reported by the railroad as "stored serviceable," 41.5 per cent have tractive power less than 40,000 lb., while 62.5 per cent rate less than 50,000 lb. The locomotives under consideration do not include those definitely reported in Car Service Division bulletins as in "Bad Order" or awaiting shop for classified repairs.

Progress in Settling the Company Union Question

CO-ORDINATOR EASTMAN on January 22 addressed a communication to the three Regional Co-ordinating Committees on the "company union" question.

In a communication of December 7 he had offered seven definite suggestions, "to the end that railroad labor practices be brought into entire harmony with the law and that a permanent basis be laid for peaceful and co-operative relations." He also expressed the hope that the committees would assume the leadership necessary to accomplish the desired results.

Later, on January 4, he met with the three committees in joint conference and it was agreed that he should receive a further report in writing informing him of the action which the committees had taken or contemplated taking. He has since received such reports, as well as reports from various individual companies.

"It appears that the committees of both the eastern and the southern groups believe that they have no jurisdiction to take action in regard to this matter as committees under the Emergency Act, except so far as the labor practices in question may be found to constitute waste and preventable expense," Mr. Eastman says, "nevertheless, they have recommended to the railroads which they represent the posting of an appropriate notice to employees, as proposed in my communication of December 7.

"These proposed notices in some respects go beyond my suggestion, and call for some comment from me. . . ."

"It is true that neither the Emergency Act nor I have 'outlawed' so-called company unions. Such unions are not prohibited, if the employees wish organizations of this character. . . .

"The question is whether the company unions have been organized and selected to represent the employees 'without interference, influence, or coercion' on the part of the railroads. The information in my possession, derived largely from returns by the railroads to my questionnaire, indicates that many of them have not been so organized and selected. It is, of course, a question of fact in each case. . .

"The Western committee forwarded a copy of my communication of December 7 to each of the western railroads, requesting that it be advised whether or not the seven suggestions would be complied with. It appears that the railroads have followed the suggestions in one way or another quite generally.

"At the conference on January 4 it was also indicated that every effort would be made by the individual railroads to guard against the victimization by subordinate officials of employees who exercise their right to join the labor organization of their choice, and that any complaints with respect to such victimization which I receive would be handled promptly by each railroad president, if referred to him by me. This is being done."

Recent Air-Conditioning Orders

ORDERS PLACED for air-conditioning equipment to be installed in railroad-owned cars during the last few months have been more numerous than at any time heretofore. Orders placed by the railroads with the Pullman Car & Manufacturing Corporation recently are as follows:

Seaboard Air Line—15 cars, including 5 coaches, 5 coach-baggage cars, 3 coach-dining cars and 2 observation-dining cars.

New York Central—58 cars, including 36 dining cars and 22 coaches.

Great Northern—12 dining cars.

Northern Pacific—19 cars, including 9 dining cars and 10 observation cars.

In addition to these, air-conditioning equipment is being installed in 480 sleeping cars for use on the Chicago, Rock Island & Pacific, the Seaboard Air Line, the Pennsylvania, the New York Central, the Chicago, Burlington & Quincy, the Great Northern and the Delaware, Lackawanna & Western.

The Atchison, Topeka & Santa Fe has ordered air-conditioning equipment for 26 passenger cars from the Safety Car Heating & Lighting Company. The cars involved include 14 dining cars, 10 lounge cars and 2 cafe cars, and the equipment will be installed in the company's shops at Topeka, Kan. This brings the total number of air-conditioned cars on the Santa Fe to 49.

Western Roads to Air-Condition 300 Cars

THE WESTERN RAILROADS have decided to air-condition the club, dining, lounge and observation cars in all of the principal through passenger trains operated in western territory prior to late spring, according to an announcement made by H. G. Taylor, chairman of the Western Association of Railway Executives. Final details of the plan have not yet been completed

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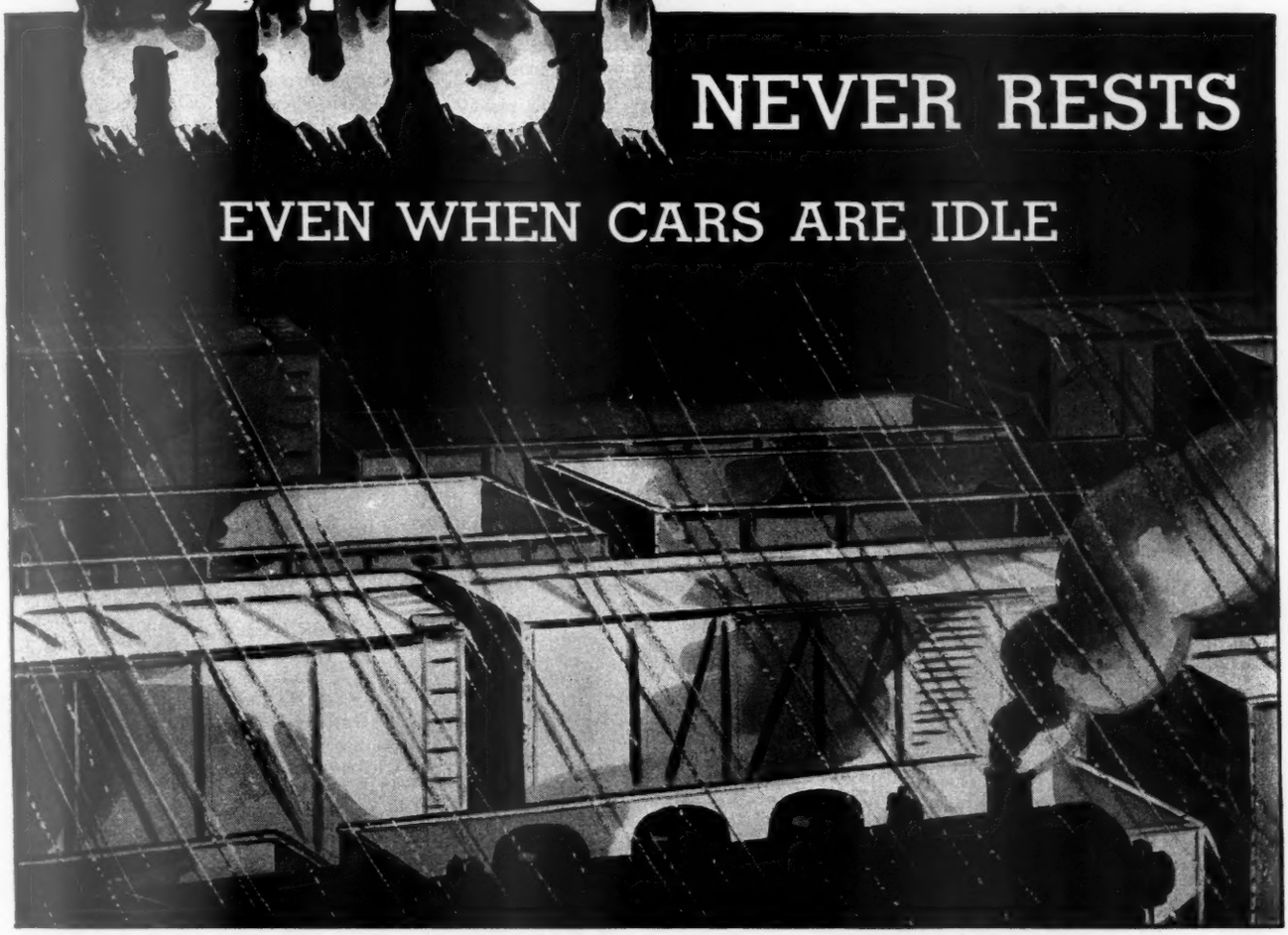
RUST NEVER RESTS

EVEN WHEN CARS ARE IDLE



Long lines of idle cars stand exposed to the weather. First paint peels off and then rust and corrosion go to work on the metal itself. » » » Then the economy of providing protection to cars in the form of rust-resisting Toncan Iron becomes apparent. How soon those cars come in for repairs is dependent upon the ability of the car sheets to resist the attacks of rust and corrosion. » » » To get full value out of the dollar you spend for car repairs use materials that give maximum life. » » » Such a material is Toncan Iron. This alloy of refined iron, copper and molybdenum ranks first among the ferrous metals after expensive stainless irons and steels in its resistance to rust and corrosion. » » » Every car re-roofing job; every replacement of rusted plates is proof of the need for more resistant car materials. » » » Toncan Iron, by increasing service life where corrosion conditions are severe, gives assurance of longer life wherever rust—the destroyer—is at work. » » » Considered on a cost-per-year basis, Toncan Iron is the most economical car repair material. » » » In these days of waste elimination, Toncan Iron deserves full consideration in your effort to reduce costs.

Toncan Iron Boiler Tubes, Pipe, Plates, Culverts, Rivets, Tender Plates and Firebox Sheets • Sheets and Strip for special railroad purposes • Agathon Alloy Steels for Locomotive Parts • Agathon Engine Bolt Steel • Agathon Iron for pins and bushings • Agathon Staybolt Iron • Climax Steel Staybolts • Upson Bolts and Nuts • Track Material, Maney Guard Rail Assemblies • Enduro Stainless Steel for dining car equipment, for refrigeration cars and for firebox sheets • Agathon Nickel Forging Steel.

The Birdsboro Steel Foundry & Machine Company of Birdsboro, Pa. has manufactured and is prepared to supply, under license, Toncan Copper Molybdenum Iron castings for locomotives.

REPUBLIC STEEL
CORPORATION
GENERAL OFFICES YOUNGSTOWN, OHIO

TONCAN
COPPER MOLYBDENUM
IRON

but it is estimated that it will include the installation of air-conditioning equipment in at least 300 cars additional to cars now so equipped.

The Standard 50-Ton Box Car

THE REGIONAL CO-ORDINATING Committees, representing the railways, have received communications from Co-ordinator Eastman, referring to the prospects for a considerable amount of car buying in the near future, as a result of the offer of the Public Works Administration to make loans to the railroads for that purpose. Five sample cars to the A. R. A. standard 50-ton, steel-sheathed, wood-lined box car designs have been built under the direction of the Car Construction Committee, Mechanical Division, American Railway Association, and have been tested at the plant of the Pullman Company. It is expected that a report of these tests, as well as observations and tests made by some of the railroads, will be submitted shortly to the Car Construction Committee and the General Committee of the Mechanical Division, to determine whether any changes or modifications are necessary in any of the sample cars.

Cleaning Air Brakes

THE SUBJECT of cleaning, oiling, testing and stenciling K-1 and K-2 air brakes is covered in a letter to members of the American Railway Association, Mechanical Division, issued under date of January 11 and signed by Secretary V. R. Hawthorne. The letter is as follows:

Rule 144 of the Rules Governing the Maintenance of Brake and Train Air Signals Equipment as revised effective August 1, 1933, and contained in Supplement No. 1 to these rules, provides that:

"At points where repairs to triple valves are made, involving main piston bushing, main piston, graduating valve, emergency piston, main piston ring, slide valve, emergency piston bushing or emergency valve brass seat, inclusive, such triple valves must be dismantled and *all parts for which A. R. A. gages are provided must be checked for wear, with gages specified.* Parts which do not conform to specified dimensions of these gages must be replaced with parts known to be within said gage limits."

Air Brake Rule 143, as revised effective August 1, 1933, further provides that "all triple valves after being cleaned or repaired must be tested on an A. R. A. standard test rack and pass the prescribed test before being placed in service. *'K' triple valves must also be tested for feed groove location.*" Letter ballot of 1933 included the adoption, as standard, of the following requirement: "A. R. A. standard triple valve test racks must be equipped with a device for locating the position of the feed groove. The device shown in Figure 1 (Circular DV-807, page 8), as furnished by the air brake manufacturers, or its equivalent, will meet the above requirements."

Interchange Rule 60, Section (g), provides that: "The cleaning marks must not be changed, or charges made for periodical cleaning of air brakes as per item 13 of Rule 111, unless all work is properly performed as required by the Standard Instructions for Periodical Repairs to Air Brakes on Freight Cars, *including the use of all A. R. A. standard triple valve wear limit gages, or approved equivalent, for checking wear, when any of the listed internal triple valve parts require repairs or renewal as prescribed therein.*"

It has been ruled that sufficient time has now elapsed to enable all railroads and car owners to provide proper gages for checking wear of triple valve parts and devices for locating the position of the feed groove, and issuing proper instructions for their use. Therefore, where these gages or devices are not being used as required by air brake Rules 143 and 144, charge for cleaning, oiling and repairing of "K" brake equipment as per item 13 of Rule 111 is not permitted, nor may the air brake cleaning marks on car be changed.

Where violation of Rules 143 and 144 are detected after January 1, 1934, by the inspectors of the Mechanical Division and charge has been rendered against car owner, refund of the amount will be required in accordance with Interchange Rule 124.

Supply Trade Notes

THE SCULLIN STEEL COMPANY, St. Louis, Mo., will resume operations in its plant on February 8 with a force of 400 men. The plant was shut down on November 15.

S K F INDUSTRIES, INC., has moved its general and executive offices from New York to Front street and Erie avenue, Philadelphia, Pa.

THE HESS-BRIGHT MANUFACTURING COMPANY will be discontinued and all future trading will be done in the name of S K F Industries, Inc., Philadelphia, Pa.

W. H. TUCKER, who has been acting manager of the New York territory of the Vapor Car Heating Company, Inc., has been appointed eastern manager, with headquarters at 75 West street, New York.

J. V. HONEYCUTT has been appointed assistant general manager of sales and E. E. Goodwillie has been appointed assistant to the vice-president in charge of sales of the Bethlehem Steel Company, both with headquarters at Bethlehem, Pa.

F. A. SHICK has been appointed vice-president and controller, J. M. Larkin, vice-president in charge of industrial and public relations and C. R. Holton, vice-president in charge of purchasing of the Bethlehem Steel Company, all with headquarters at Bethlehem, Pa.

J. B. DURKEE has been appointed manager of the Houston, Tex., office of the A. M. Byers Company, Pittsburgh, Pa. Mr. Durkee formerly represented the company in the Houston territory and more recently in Tulsa, Okla. He succeeds H. B. Weathersby, who died on December 19.

S. M. D. CLAPPER has been elected president of the General Refractories Company, Philadelphia, Pa., succeeding John R. Sproul, who has resigned. Mr. Clapper had been chairman of the board of the company, which post is now vacated. Mr. Sproul also resigned as a director of the company and was appointed assistant to the president.

A MERGER of the Ambler Asbestos Shingle & Sheathing Company with the Keasbey & Mattison Company, both of Ambler, Pa., and the acquisition of a controlling interest in the latter company by Turner & Newall, Ltd., of Great Britain, has been announced by A. S. Blagden, president of the American companies. The enlarged business will retain the name of Keasbey & Mattison Company.

FRED P. BIGGS has been appointed assistant vice-president of the American Brake Shoe & Foundry Company, with headquarters at Chicago. Mr. Biggs entered the employ of this company in 1916 as a service engineer with headquarters at New York. During the World War he served as a military aviator both in this country and in France and at the conclusion of the war he resumed his duties as service engineer. In 1922 he was transferred to Chicago as salesman, which position he held until his appointment as assistant vice-president.

LUCIAN C. BROWN, vice-president in charge of sales of the Elwell-Parker Electric Company, Cleveland, Ohio, has resigned.

A. B. NILSEN, formerly with the late Fred K. Shults, New York, for nine years, has succeeded Mr. Shults with the Bettendorf Company, Bettendorf, Ia., and the MacLean-Fogg Lock Nut Company, Chicago, as sales representative for these companies in the eastern territory. Mr. Nilsen continues at the same address, Room 2043, Grand Central Terminal, New York City.

F. R. FAULK has been appointed Pittsburgh district representative for Universal arc welders, accessories and welding electrodes by the Universal Power Corporation, Cleveland, Ohio. His headquarters are at 50 Penn avenue, Pittsburgh, Pa. The Welding Equipment & Supply Company, 2720 East Grand Boulevard, Detroit, Mich., has also been appointed distributor for Universal arc welders, accessories and electrodes.

CLINTON L. BARDO, president of the New York Shipbuilding Company and formerly general manager of the New York, New Haven & Hartford, has been elected president of the National Association of Manufacturers, succeeding Robert L. Lund, who headed the association for two years; Mr. Lund was elected chairman of the board of the organization. Three new vice-presidents were chosen by the directorate as follows: George H. Houston, president of the Baldwin Locomotive Works, Philadelphia, Pa.; E. C. Heidrich, Jr., president of the Peoria Cordage Company, Peoria, Ill., and Charles R. Hook, president of the American Rolling Mills Company, Middletown, Ohio.

JOHN H. TRENT has been elected vice-president of the Johns-Manville Sales Corporation, with headquarters at New York. Mr. Trent was previously general sales manager in charge of the transportation and government sales. He was born in Meade County, Ky., and was educated in the public schools of Paducah, Ky. In 1901, he entered the service of the Illinois Central and after serving in the mechanical and stores departments of the Burnside shops, Chicago, he became storekeeper at Water Valley, Miss., subsequently serving at Memphis, Tenn., and Paducah, Ky. Mr. Trent has been associated with the Johns-Manville Sales Corporation and its predecessors for over 25 years, having served as sales manager of the western region with headquarters at Chicago, prior to his appointment as general sales manager in charge of the entire sales of the Transportation and Government departments, with headquarters at New York. Mr. Trent in his capacity as vice-president will be in charge of all functions of the Transportation department in the United States and Canada embodying steam railroads, electric railway, motor bus and aviation divisions.

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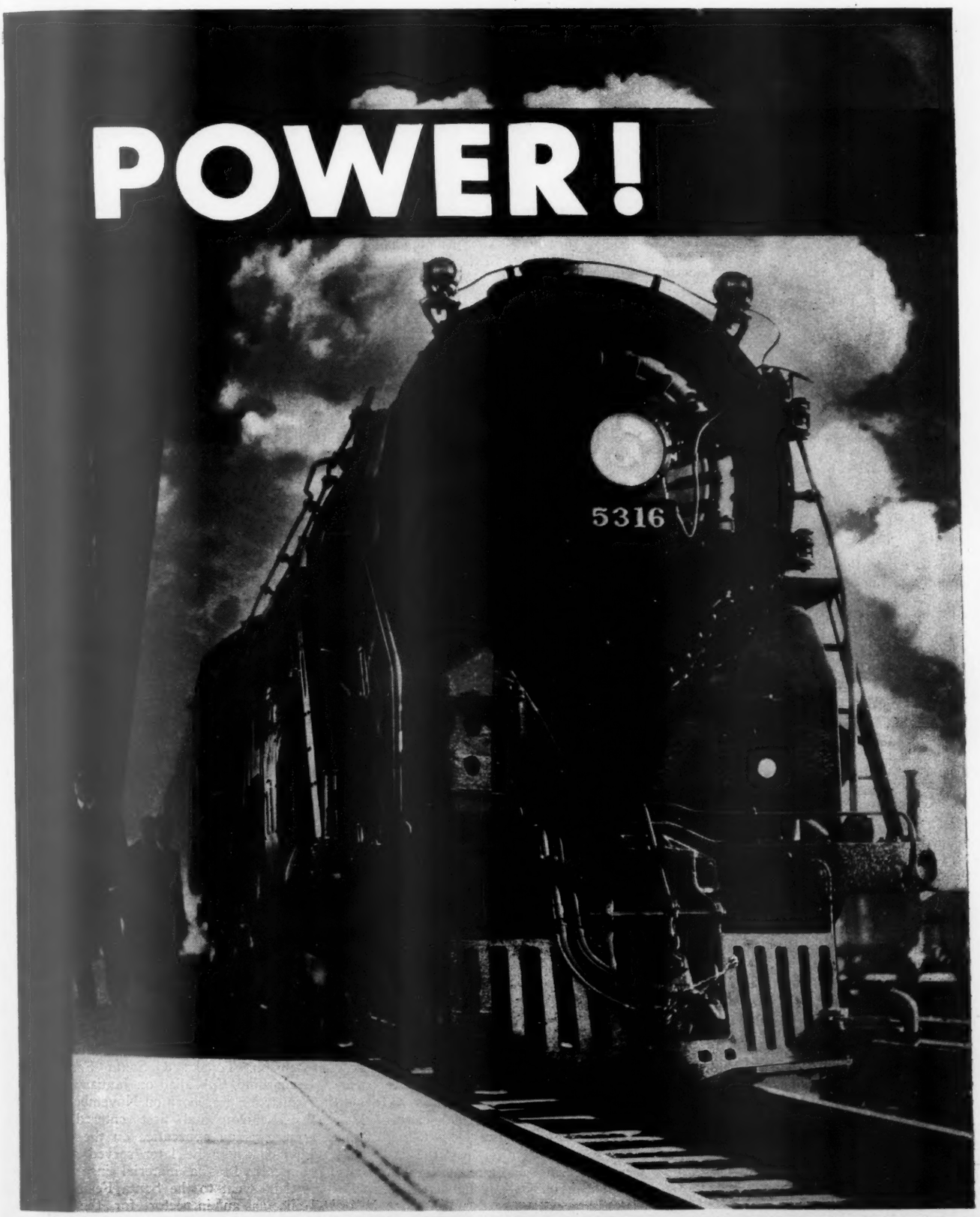

The Locomotive Booster supplies power you can get in no other way because it capitalizes idle weight and spare steam.

FRANKLIN RAILWAY SUPPLY COMPANY, INC., NEW YORK, CHICAGO, MONTREAL

WILLIAM I. HOWLAND, JR., assistant general manager of sales of the Illinois Steel Company, Chicago, has been elected vice-president and general manager of sales, to succeed Edwin S. Mills, who has resigned in the interest of his health. Mr. Howland graduated from Yale university in 1908, with the degree of mechanical engineer, and in the same year entered the employ of the Illinois Steel Company in the operating department. He was later

William I. Howland, Jr.

transferred to the sales department, where he remained until 1916, when he was placed in charge of sales of alloy and electric steel for the Illinois Steel Company and the Carnegie Steel Company. In 1917, he entered the United States Navy and in 1919 returned to the employ of the Illinois Steel Company as assistant sales manager in the bar department. On December 1, 1926, he was promoted to the position of assistant general manager of sales of bars, strips and alloy steels, which he held until his recent election.

Mr. Mills was born at New Britain, Pa., on January 5, 1870, and in 1895 entered the employ of the Carnegie Steel Company as manager of sales at Cleveland, Ohio. Subsequently, he was general manager of the Pittsburgh Steamship Company, agent of the Oliver Iron Mining Company, and assistant to the first vice-president of the United States Steel Corporation at New York. From 1910 to 1919 he served as special sales agent of the Carnegie Steel Company and in the latter year was appointed general manager of sales of the Illinois Steel Company. Mr. Mills served also as manager of sales of the Carnegie Steel Company and the Tennessee Coal, Iron & Railroad Company. In 1926 he was elected vice-president and general manager of sales of the Illinois Steel Company.

Obituary

ROY J. COOK, who retired in 1931 as president of the Keyoke Railway Equipment Company, Chicago, died suddenly on January 17.

GEORGE J. MARTIN, eastern representative of the Union Asbestos & Rubber Company and the Equipment Specialties Company, with headquarters in New York, died in that city on January 16.

SAMUEL M. HINDMAN of the Schaefer Equipment Company, Pittsburgh, Pa., died on January 2, after a long illness at the age of 61 years.

J. P. BOURKE, vice-president of the Ewald Iron Company, Inc., at New York, died suddenly of a heart attack on January 17, at his home in Larchmont, N. Y.

WILLIAM BANCROFT POTTER, for many years engineer of the General Electric Company's railway department, died on January 15 at his home in Schenectady, N. Y.

JAMES HARTNESS, until last year president of the Jones & Lamson Machine Company, and formerly governor of Vermont, died at his home at Springfield, Vt., on February 3, after several months' illness. Mr. Hartness was born at Schenectady, N. Y., on September 3, 1861. He attended the public schools in Cleveland, Ohio, and was governor of Vermont for one term, 1921-23. While he never went to college, he received from the University of Vermont honorary degree of doctor of laws and master of engineering, the former in 1910 and the latter in 1921, and from Yale, in 1914, the degree of master of arts. Mr. Hartness had patents for more than 100 inventions, among them the Hartness flat turret lathe, Hartness automatic die, and Hartness screw-thread comparator. He became associated with the Jones & Lamson Machine Company in 1888, serving consecutively as superintendent, manager and president. He was Federal food ad-

James Hartness

ministrator for Vermont during the World War and a member of the commission that represented the United States at the Inter-Allied Aircraft Standardization Conference at London and Paris. At the same time he was chairman of the Committee on Public Safety for Vermont. After his term as governor Mr. Hartness succeeded President Hoover as president of the American Engineering Council. He was a former president of the American Society of Mechanical Engineers (1914), a fellow of the American Association for the Advancement of Science and a member of the British Institution of Mechanical Engineers. He had served also as vice-chairman of the Congressional Screw Thread Standardization Commission and was the author of "Machine Building for Profit" and "The Human Factor in Works Management." He was the recipient of the John Scott medal, given by the American Philosophical Society, for useful invention, and the Edward Longstreth Medal by the Franklin Institute of Philadelphia.

Personal Mention

General

FREDERICK E. LYFORD, special engineer to the executive vice-president, and more recently special engineer to the superintendent of motive power of the Lehigh Valley, has resigned and has been appointed an examiner for the Railroad Division of the Reconstruction Finance Corporation, with headquarters at Washington, D. C. Mr. Lyford will be a member of the staff of J. W. Barriger, chief examiner of the Railroad Division, and his principal duties will be field investigation of equipment and shop conditions, mechanical practices and related subjects in connection with comprehensive studies being made of railroads in the hands of receivers or trustees, to which R. F. C. loans have been made. Mr. Lyford was born on January 20, 1895, and was graduated in mechanical engineering from Cornell University. After a year in the service of a shipbuilding concern and a machine tool company, he entered the army, serving in the field artillery and in the air service in France as first lieutenant. In 1919 he became assistant sales manager of the Allied Machinery Company of America at New York, which position he resigned in the following year to engage in advertising and sales promotion work for a milling company at Waverly, N. Y. In 1923 he entered the service of the Lehigh Valley as apprentice instructor and also directed classes for the instruction of mechanical department foremen. Subsequently he served as assistant general machine foreman at the Sayre locomotive shops of the Lehigh Valley, during which period he also handled engineering matters for the shop superintendent. Thereafter he was promoted to special engineer to the executive vice-president, in which capacity he made special studies of a wide variety of subjects connected with mechanical department questions, including feedwater heating, water treatment, locomotive lubrication and the design and economy of new motive power.

WILLIAM DONOHUE has been appointed acting master mechanic of the Southern Pacific Lines in Texas and Louisiana, with headquarters at Ennis, Tex.

Obituary

ALEXANDER G. ARMSTRONG, superintendent of shops for the Coast Lines of the Atchison, Topeka & Santa Fe, at San Bernardino, Cal., died on January 12. Mr. Armstrong was born on November 4, 1872, in Michigan and first entered railway service as an apprentice on the Northern Pacific, where he later served as a machinist and as a material inspector. In 1903 he went to the Santa Fe at Topeka, Kan., as an inspector for the Baldwin Locomotive Works, later being appointed a foreman in the Santa Fe shops at San Bernardino. In 1911 he was promoted to the position of division foreman at Los Angeles, Cal., and in 1913 became master mechanic at Needles, Cal. Subsequently Mr. Armstrong was transferred to San Bernardino where he was appointed superintendent of shops in March, 1918.